Unit I: Computer Education, Hardware and Software of Computers and Latest Trends in Information Technology

A computer system consists of two major elements: hardware and software. Computer **hardware** is the collection of all the parts you can physically touch. Computer **software**, on the other hand, is not something you can touch. Software is a set of instructions for a computer to perform specific operations. You need both hardware and software for a computer system to work.

Hardware Components of Computer

Computer hardware is the collection of physical parts of a computer system. This includes the computer case, monitor, keyboard, and mouse. It also includes all the parts inside the computer case, such as the hard disk drive, motherboard, video card, and many others. Computer hardware is what you can physically touch.

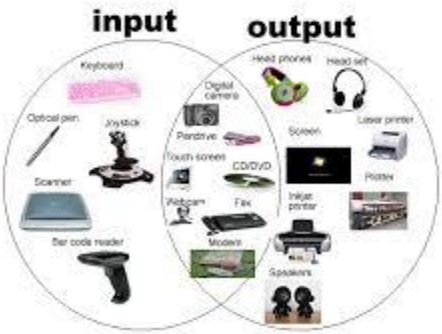
Some hardware components are easy to recognize, such as the computer case, keyboard, and monitor. However, there are many different types of hardware components. In this lesson, you will learn how to recognize the different components and what they do.

Input and Output Devices

In computing, **input/output** or **I/O** (or, informally, **io** or **IO**) is the communication between an information processing system, such as a computer, and the outside world, possibly a human or another information processing system. Inputs are the signals or data received by the system and outputs are the signals or data sent from it. The term can also be used as part of an action; to "perform I/O" is to perform an input or output operation.

I/O devices are the pieces of hardware used by a human (or other system) to communicate with a computer. For instance, a keyboard or computer mouse is an input device for a computer, while monitors and printers are output devices. Devices for communication between computers, such as modems and network cards, typically perform both input and output operations.

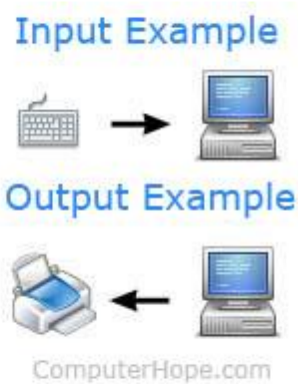
The designation of a device as either input or output depends on perspective. Mouse and keyboards take physical movements that the human user outputs and convert them into input signals that a computer can understand; the output from these devices is the computer's input. Similarly, printers and monitors take signals that a computer outputs as input, and they convert



these signals into a representation that human users can understand. From the human user's perspective, the process of reading or seeing these representations is receiving input; this type of interaction between computers and humans is studied in the field of human–computer interaction.

In computer architecture, the combination of the CPU and main memory, to which the CPU can read or write directly using individual instructions, is considered the brain of a computer. Any transfer of information to or from the CPU/memory combo, for example by reading data from a disk drive, is considered I/O.[1] The CPU and its supporting circuitry may provide memory-mapped I/O that is used in low-level computer programming, such as in the implementation of device drivers, or may provide access to I/O channels. An I/O algorithm is one designed to exploit locality and perform efficiently when exchanging data with a secondary storage device, such as a disk drive.

Difference between an input and output device?



An input device sends information to a computer system for processing, and an output device reproduces or displays the results of that processing. Input devices *only* allow for input of data to a computer and output devices *only* receive the output of data from another device.

Most devices are only input devices or output devices, as they can only accept data input from a user or output data generated by a computer. However, some devices can accept input and display output, and they are referred to as I/O devices (input/output devices).

For example, as you can see in the top half of the image to the right, a keyboard sends electrical signals, which are received by the computer as **input**. Those signals are then interpreted by the computer and displayed, or **output**, on the monitor as text or images. In the lower half of the image, the computer sends, or **outputs**, data to a printer, which will print the data onto a piece of paper, also considered **output**.

Input devices

An **input** device can send data to another device, but it cannot receive data from another device. Examples of input devices include the following.

- **Keyboard** and **Mouse** - Accepts input from a user and sends that data (input) to the computer. They cannot accept or reproduce information (output) from the computer.
- **Microphone** - Receives sound generated by a user or other source (input) and sends that sound to a computer. It cannot receive and reproduce (output) sound sent by other devices.
- **Webcam** - Receives images generated by whatever it is pointed at (input) and sends those images to a computer. It cannot receive and reproduce (output) images sent by other devices.

Output devices

An **output** device can receive data from another device and generate output with that data, but it cannot send data to another device. Examples of output devices include the following.

- **Monitor** - Receives data from a computer (output) and displays that information as text and images for users to view. It cannot accept data from a user or other source and send that data to another device.
- **Projector** - Receives data from a computer (output) and displays, or projects, that information as text and images onto a surface, like a wall or a screen. It cannot accept data from a user or other source and send that data to another device.
- **Speakers** - Receives sound data from a computer or other device (output) and plays the sounds for users to hear. It cannot accept sound generated by users and send that sound to another device.

An **input/output** device can receive data from users or another device and also send data to another device. Examples of input/output devices include the following.

- **CD-RW drive** and **DVD-RW drive** - Receives data from a computer (input), to copy onto a writable CD or DVD. Also, the drive sends data contained on a CD or DVD (output) to a computer.
- **USB flash drive** - Receives, or saves, data from a computer or other device (input). Also, the drive sends data to a computer or another device (output).

Types of Computers

Before looking at the various components, it is useful to distinguish between two different types of computers: desktop computers and laptop computers. A **desktop computer** consists of a computer case and a separate monitor, keyboard, and mouse. As the name suggests, this type of computer is typically placed on a desk and is not very portable.

A **laptop computer** has the same components but integrated into a single unit.

While these two types of computers look quite different, they have the same general hardware components.

Hardware Components

Let's start with the **computer case**. This is the metal enclosure that contains many of the other hardware components. It comes in various shapes and sizes, but a typical **tower** model is between 15-25 inches high. Want to know what's inside? Okay, go get a screwdriver and let's open it up. Seriously, if you are really into computers, the best way to learn is to actually get hands-on. To save us some time, however, have a look at this desktop computer case. A computer enthusiast replaced the metal side panel with a transparent one, so we can have a look inside.

Although that photo looks pretty cool, it is a bit hard to recognize the individual components, especially with all the connecting wires running through it. This figure shows a more schematic version of a desktop computer, which makes it easier to point out the essential hardware components.

Software

Software is a general term for the various kinds of programs used to operate computers and related devices. (The term hardware describes the physical aspects of computers and related devices.)

Software can be thought of as the variable part of a computer and hardware the invariable part. Software is often divided into application software (programs that do work users are directly interested in) and system software (which includes operating systems and any program that supports application software). The term middleware is sometimes used to describe programming that mediates between application and system software or between two different kinds of application software (for example, sending a remote work request from an application in a computer that has one kind of operating system to an application in a computer with a different operating system).

An additional and difficult-to-classify category of software is the *utility*, which is a small useful program with limited capability. Some utilities come with operating systems. Like applications, utilities tend to be separately installable and capable of being used independently from the rest of the operating system.

Applets are small applications that sometimes come with the operating system as "accessories." They can also be created independently using the Java or other programming languages.

Software can be purchased or acquired as shareware (usually intended for sale after a trial period), liteware (shareware with some capabilities disabled), freeware (free software but with copyright restrictions), public domain software (free with no restrictions), and open source (software where the source code is furnished and users agree not to limit the distribution of improvements).

Software is often packaged on CD-ROMs and *diskettes*. Today, much purchased software, shareware, and freeware is downloaded over the Internet. A new trend is software that is made available for use at another site known as an application service provider.

Some general kinds of application software include:

- Productivity software, which includes word processors, spreadsheets, and tools for use by most computer users
- Presentation software
- Graphics software for graphic designers
- CAD/CAM software
- Specialized scientific applications
- Vertical market or industry-specific software (for example, for banking, insurance, retail, and manufacturing environments)

Firmware or *microcode* is programming that is loaded into a special area on a microprocessor or read-only memory on a one-time or infrequent basis so that thereafter it seems to be part of the hardware.

System software

System software is a type of computer program that is designed to run a computer's hardware and application programs. If we think of the computer system as a layered model, the system software is the interface between the hardware and user applications.

The operating system (OS) is the best-known example of system software. The OS manages all the other programs in a computer.

Other examples of system software and what each does:

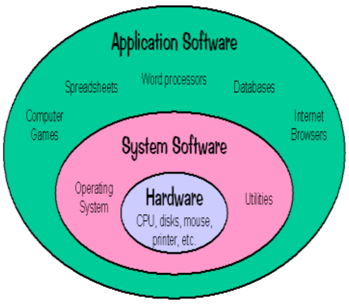
- The BIOS (basic input/output system) gets the computer system started after you turn it on and manages the data flow between the operating system and attached devices such as the hard disk, video adapter, keyboard, mouse, and printer.
- The boot program loads the operating system into the computer's main memory or random access memory (RAM).
- An assembler takes basic computer instructions and converts them into a pattern of bits that the computer's processor can use to perform its basic operations.

- A device driver controls a particular type of device that is attached to your computer, such as a keyboard or a mouse. The driver program converts the more general input/output instructions of the operating system to messages that the device type can understand.
- According to some definitions, system software also includes system utilities, such as the disk defragmenter and System Restore, and development tools such as compilers and debuggers.

Application Software

An **application software** (**app** or **application** for short) is computer software designed to perform a group of coordinated functions, tasks, or activities for the benefit of the user. Examples of an application include a word processor, a spreadsheet, an accounting application, a web browser, a media player, an aeronautical flight simulator, a console game or a photo editor. The collective noun **application software** refers to all applications collectively. This contrasts with system software, which is mainly involved with running the computer.

Applications may be bundled with the computer and its system software or published separately, and may be coded as proprietary, open-source or university projects. Apps built for mobile platforms are called mobile apps.

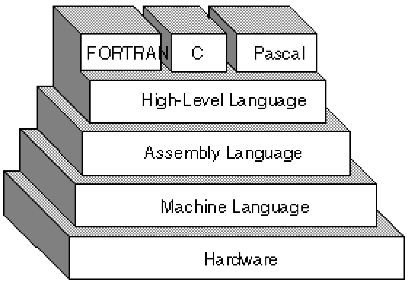


Difference between System Software and Application Software

S.No.	System Software	Application Software
1.	System software is used for operating computer hardware.	Application software is used by user to perform specific task.
2.	System software are installed on the computer when operating system is installed.	Application software are installed according to user's requirements.

3.	In general, the user does not interact with system software because it works in the background.	In general, the user interacts with application software.
4.	System software can run independently. It provides platform for running application software.	Application software can't run independently. They can't run without the presence of system software.
5.	Some examples of system software are compiler, assembler, debugger, driver, etc.	Some examples of application software are word processor, web browser, media player, etc.

High Level Language



A ***h**igh-**l**evel **l**anguage* (**HLL**) is a programming language such as C, FORTRAN, or Pascal that enables a programmer to write programs that are more or less independent of a particular type of computer. Such languages are considered high-level because they are closer to human languages and further from machine languages.

In contrast, assembly languages are considered low-level because they are very close to machine languages.

Advantages of High-Level Languages

The main advantage of high-level languages over low-level languages is that they are easier to read, write, and maintain. Ultimately, programs written in a high-level language must be translated into machine language by a compiler or interpreter.

The first high-level programming languages were designed in the 1950s. Now there are dozens of different languages, including Ada, Algol, BASIC, COBOL, C, C++, JAVA, FORTRAN, LISP, Pascal, and Prolog.

Using computers in schools

Nowadays every school has to have computers. I don't refer to legal requirement but to perception. Schools are judged on how many computers they have. It would be more to the point if they were judged on their computer-savvy.

I'm a fan of computers; my computer is a vital part of my work. I believe computer literacy is as important for our children to acquire as any other "basic skill". But I'm not a fan of the wholesale introduction of computers into our schools, particularly the junior ones. How many computers a school has is not the issue - the issue is, how do they use them?
In many cases, the answer is: poorly.

The reasons are simple enough. Foremost, the teachers have insufficient training and experience with computers. Relatedly, computers are not yet an integrated part of the school curriculum, and every school and teacher re-invents the wheel, trying to find good software, trying to work out how to fit it into the classroom curriculum, trying to work out schedules to make sure every student gets a fair go, struggling with the lack of technical support. And of course, in many cases (perhaps most), the computers are old, with the associated problems of being more likely to have technical problems, being slow, limited in memory, incompatible with current software, and so on.

The most important problems schools have with computers:

- lack of financial resources (to buy enough computers, up-to-date computers, enough printers and other peripherals, licenses for good software, technical support)
- the inability of teachers to know how to use the computers effectively
- difficulty in integrating computers into the school / classroom curriculum (problems of use, of scheduling, of time)

Using computers effectively is much more than simply being able to type an essay or produce a graph. Parents and educators who deplore the obsession with computers in schools see computers as eroding children's basic skills and knowledge, because they only see computers being used as copy-and-paste and making-it-pretty devices. But computers have potential far beyond that.

Computers can be used to help:

- extend the scope of searches
- retrieve precisely targeted data with greater speed and accuracy

- increase the amount of data held ready for use
- sift relevant data from irrelevant
- turn data into information

The true value of a computer isn't seen until the user can use it not only as a **presentation tool** (for making work attractive), and as a **productivity tool** (for producing work more quickly, effectively, thoroughly), but also as a **cognitive tool**.

Using computers as cognitive tools

A cognitive tool helps you *think*.

Many people thought computers would revolutionize education by providing individual instruction in the form of tutorials. In particular, as a means of drilling students. Drilling can be helpful to overlearn a skill to achieve automaticity, but it doesn’t help transfer to meaningful problems. That is, you can learn a skill, you can rote-learn facts, but drilling doesn't help meaningful learning - it doesn't teach understanding.

Although computer tutorials have become somewhat more sophisticated, they still only present a single interpretation of the world - they don’t allow students to find their own meaning. They don't teach students to reflect on and analyze their own performance.

So, the computer itself isn't the issue - the issue, as always, is what you do with it. For example, when the Web is simply used as a source of material that can be downloaded and pasted without thought, then no, it is not of value. But when the learner searches the Web, evaluates the information, finds the gold in the dross, uses that to construct a knowledge base, to develop meaning, then yes, it is a valuable resource.

Computers can support meaningful learning by
- reducing time spent on mechanical tasks such as rewriting, producing graphs, etc
- helping find information
- helping organize information
- making it easier to share information and ideas with others

Computer Software

Computer software is programming code executed on a computer processor. The code can be machine-level code, or code written for an operating system. An **operating system** is software intended to provide a predictable and dependable layer for other programmers to build other software on, which are known as **applications**. It also provides a dependable layer for hardware manufacturers. This standardization creates an efficient environment for programmers to create smaller programs, which can be run by millions of computers. Software can also be thought of as an expression that contrasts with hardware. The physical components of a computer are the hardware; the digital programs running on the hardware are the software. Software can also be updated or replaced much easier than hardware. Additionally, software can be distributed to a number of hardware receivers. Basically, software is the computer logic computer users interact with.

Ethical Issues:
Every person sets some goals to be achieved in life, both personal goals and professional goals. One has to work towards achieving these goals. Achieving these goals is important, so is the means and ways to achieve them. Is it OK to take bribe to get rich? Is it OK to suppress the fact that the software you developed still has bugs just to ensure that the deadline given by the manager is met? Ethical issues come into picture and the individual has to decide what to do depending on what one's conscience says.

As software has become the lifeline of many systems, the software professional needs to be aware of the ethical issues connected with the software engineering and it is the manager's responsibility to bring this awareness to all the team members. We will discuss the ethical issues and the code of ethics for software professionals.

Human Ethics

Every human being has certain responsibilities towards the society and the surrounding environment. As good citizens of the world, we all have to contribute our might to make the world a better place to live in. As human beings, we have to follow certain principles to achieve this. Our responsibilities include doing good for the society and following the rules and regulations set by the government for one's country's growth, prosperity and security. While doing so, one may encounter conflicts—as to what is 'good' and what is 'bad'. We hear a number of episodes wherein individuals fight rules and regulations—it is such people, who create history and also contribute to the growth of the profession. As an example, one may feel that the regulations framed by governments are not correct (for instance the regulation that encryption software cannot be exported). If one has a strong conviction that it is not correct, one can fight against it. Ethical issues are highly subjective and one has to be guided by one's conscience.

Professional Ethics

A professional, doctor or engineer or chartered accountant, has further obligations to the society because professionals play a greater role in designing the future for the rest of the society. Every professional has to adhere to a 'code of ethics'—the guidelines to be followed while discharging one's duties as a professional.

The code of ethics framed by IEEE, the largest professional body of electrical and electronics engineers, can be found at the web site **http://www.ieee.org**

Ethical Issues in Software Engineering

With the influence of computers on all walks of life and the role of software in all the systems, software professionals have the power to do good or bad to the society. As responsible human beings and as professionals, we need to use the knowledge and skills for the benefit of the society. Every software professional has to follow a code of ethics keeping in view the importance of quality software development and the ill effects of defective software. The quality of software will affect the society and human life—the impact of defective software in such systems as medical equipment, transportation systems, nuclear plants, banking etc., are not difficult to imagine.

IEEE Computer Society and Association for Computing Machinery (ACM), two major professional bodies jointly established a task force to frame software engineering code of ethics and professional practice. According to this code, every software professional has obligations to

(a) Society
(b) Self
(c) Profession
(d) Product
(e) Employer
(f) Client
(g) Colleagues

These obligations have to be fulfilled by every person as

(a) human being
(b) professional
(c) software engineering professional

While discharging one's duties, sometimes there may be a conflict between the obligations to different entities. Consider the following examples:

At the place of work, you may be constrained to violate copyright laws. What would you do?

- The employer (or the manager to whom you report) insists on violating intellectual property rights by asking you to use software developed by someone else. Would you accept to do it or not?

- The employer insists on delivering software to the client in spite of the fact that there are some known defects. You insist on informing the client about the defects, your employer says no. What stand do you take? If the software is to be used in the intensive care unit of a hospital, would you accept?

- A colleague of yours is passing the confidential information of your organization to an outsider. Will you be silent or inform your superiors?

The answers to these questions (and many more such questions which we encounter during our careers) depend on whether we promote our self-interest or accept what the manager/employer says; or as professionals with ethical values, use our judgment to do what we think is RIGHT—irrespective of the consequences.

Code of Ethics for Software Engineers

Ethical issues have no boolean (yes/no) answer. One has to use one's own judgment and do what one feels is right. Many professional bodies formulated code of ethics, a set of guidelines, which can be used by professionals to make judgments.

Ethical Issues: Right versus Wrong

While pursuing a career in software engineering, we all encounter situations in which there may not be right/wrong answer for a particular question. In such cases, one should always use one's own judgment to decide what is right and what is wrong, but that judgment should be based on realistic reasoning and with adequate background information. For instance, there are professionals who feel that working in defense organizations particularly in projects for destroying mankind is wrong; but many of those who work on such projects are proud of their contributions for the defense of their countries. These are two different viewpoints—it is not correct to say that one is right and the other is wrong. One has to decide for oneself.

The broad guidelines as given in the code of ethics are to ensure that no damage is done to human life and society at large for the sake of personal advancement. Every software professional's main objective must be to improve the quality of life.

Everywhere, money, power and fame drive human beings. To achieve their personal goals, the ethics are set aside resulting in corruption, crime and unhealthy social life. Professionals who have a great role to play to make the world a better place to live, need to follow the code of ethics. As software becomes the lifeline of many critical systems, the software professionals have a great responsibility so that the society respects the software profession. It is not enough to have technical competence, one has to have social consciousness and contribute to improve the quality of life through ethical behavior.

Software Piracy

Software piracy is defined as the illegal duplication of proprietary software to evade purchasing said software and the selling of unauthorized duplicates.

Consequences of Software Piracy

The losses suffered as a result of software piracy directly affect the profitability of the software industry. Because of the money lost to pirates, publishers have fewer resources to devote to research and development of new products, have less revenue to justify lowering software prices and are forced to pass these costs on to their customers. Consequently, software publishers, developers, and vendors are taking serious actions to protect their revenues.

Using pirated software is also risky for users. Aside from the legal consequences of using pirated software, users of pirated software forfeit some practical benefits as well. Those who use pirate software:

- Increase the chances that the software will not function correctly or will fail completely;
- Forfeit access to customer support, upgrades, technical documentation, training, and bug fixes;
- Have no warranty to protect themselves;
- Increase their risk of exposure to a debilitating virus that can destroy valuable data;
- May find that the software is actually an outdated version, a beta (test) version, or a nonfunctioning copy;
- Are subject to significant fines for copyright infringement; and
- Risk potential negative publicity and public and private embarrassment.

It is also worth noting that the use of pirated software also drives up the costs for legitimate users - which gives legitimate users all the more reason to help fight piracy by reporting to those organizations and individuals who are not "playing by the rules."

Computer Technology

The process of utilizing computer technology to complete a task. Computing may involve computer hardware and/or software, but must involve some form of a computer system.

Use of Robots

A robot is a machine—especially one programmable by a computer—capable of carrying out a complex series of actions automatically. Robots can be guided by an external control device or the control may be embedded within. Robots may be constructed to take on human form but most robots are machines designed to perform a task with no regard to how they look.

Robots can be autonomous or semi-autonomous and range from humanoids such as Honda's *Advanced Step in Innovative Mobility* (ASIMO) and TOSY's *TOSY Ping Pong Playing Robot* (TOPIO) to industrial robots, medical operating robots, patient assist robots, dog therapy robots, collectively programmed *swarm* robots, UAV drones such as General Atomics MQ-1 Predator, and even microscopic nano robots. By mimicking a lifelike appearance or automating movements, a robot may convey a sense of intelligence or thought of its own. Autonomous Things are expected to proliferate in the coming decade, with home robotics and the autonomous car as some of the main drivers.

The branch of technology that deals with the design, construction, operation, and application of robots, as well as computer systems for their control, sensory feedback, and information processing is robotics. These technologies deal with automated machines that can take the place of humans in dangerous environments or manufacturing processes, or resemble humans in appearance, behavior, or cognition. Many of today's robots are inspired by nature contributing to the field of bio-inspired robotics. These robots have also created a newer branch of robotics: soft robotics.

Artificial Intelligence

Artificial intelligence (**AI**), sometimes called **machine intelligence**, is intelligence demonstrated by machines, in contrast to the **natural intelligence** displayed by humans and other animals. In computer science AI research is defined as the study of "intelligent agents": any device that perceives its environment and takes actions that maximize its chance of successfully achieving its goals.[1] Colloquially, the term "artificial intelligence" is applied when a machine mimics "cognitive" functions that humans associate with other human minds, such as "learning" and "problem solving

The scope of AI is disputed: as machines become increasingly capable, tasks considered as requiring "intelligence" are often removed from the definition, a phenomenon known as the AI effect, leading to the quip, "AI is whatever hasn't been done yet. For instance, optical character recognition is frequently excluded from "artificial intelligence", having become a routine technology. Modern machine capabilities generally classified as AI include successfully understanding human speech, competing at the highest level in strategic game systems (such as chess and Go), autonomous cars, intelligent routing in content delivery network and military simulations.

Artificial intelligence was founded as an academic discipline in 1956, and in the years since has experienced several waves of optimism, followed by disappointment and the loss of funding (known as an "AI winter") followed by new approaches, success and renewed funding. For most of its history, AI research has been divided into subfields that often fail to communicate with each other.[12] These sub-fields are based on technical considerations, such as particular goals (e.g. "robotics" or "machine learning"), the use of particular tools ("logic" or artificial neural networks), or deep philosophical differences. Subfields have also been based on social factors (particular institutions or the work of particular researchers).

Office Automation

Office automation refers to the varied computer machinery and software used to digitally create, collect, store, manipulate, and relay office information needed for accomplishing basic tasks. Raw data storage, electronic transfer, and the management of electronic business information comprise the basic activities of an office automation system. Office automation helps in optimizing or automating existing office procedures.

The backbone of office automation is a LAN, which allows users to transfer data, mail and even voice across the network. All office functions, including dictation, typing, filing, copying, fax, Telex, microfilm and records management, telephone and telephone switchboard operations, fall into this category. Office automation was a popular term in the 1970s and 1980s as the desktop computer exploded onto the scene.

Advantages are:

1. Office automation can get many tasks accomplished faster.
2. It eliminates the need for a large staff.
3. Less storage is required to store data.
4. Multiple people can update data simultaneously in the event of changes in schedule

Multimedia

Multimedia means that computer information can be represented through audio, video, and animation in addition to traditional media (i.e., text, graphics drawings, images).

Multimedia is the field concerned with the computer-controlled integration of text, graphics, drawings, still and moving images (Video), animation, audio, and any other media where every type of information can be represented, stored, transmitted and processed digitally.

A ***Multimedia Application*** is an Application which uses a collection of multiple media sources e.g. text, graphics, images, sound/audio, animation and/or video.

Hypermedia can be considered as one of the multimedia applications.

Desktop Publishing

Desktop publishing (abbreviated DTP) is the creation of documents using page layout skills on a personal ("desktop") computer primarily for print. Desktop publishing software can generate layouts and produce typographic quality text and images comparable to traditional typography and printing. This technology allows individuals, businesses, and other organizations to self-publish a wide range of printed matter. Desktop publishing is also the main reference for digital typography. When used skillfully, desktop publishing allows the user to produce a wide variety of materials, from menus to magazines and books, without the expense of commercial printing.

Desktop publishing combines a personal computer and WYSIWYG page layout software to create publication documents on a computer for either large scale publishing or small scale local multifunction peripheral output and distribution. Desktop publishing methods provide more control over design, layout, and typography than word processing. However, word processing software has evolved to include some, though by no means all, capabilities previously available only with professional printing or desktop publishing.

The same DTP skills and software used for common paper and book publishing are sometimes used to create graphics for point of sale displays, promotional items, trade show exhibits, retail package designs and outdoor signs. Although what is classified as "DTP software" is usually limited to print and PDF publications, DTP skills aren't limited to print. The content produced by desktop publishers may also be exported and used for electronic media. The job descriptions that include "DTP", such as DTP artist, often require skills using software for producing e-books, web content, and web pages, which may involve web design or user interface design for any graphical user interface.

Desktop Publishing Software for Windows

- Adobe InDesign
- Adobe PageMaker, discontinued in 2004
- Calamus
- Corel Draw
- Corel Ventura, previously Ventura Publisher, originally developed by Xerox, now owned by Corel
- First Publisher, was ClickArt Personal Publisher (by T/Maker Company)
- FrameMaker, now owned by Adobe
- InPage - DTP which works with English + Urdu, Arabic, Persian, Pashto etc.
- Microsoft Publisher
- PagePlus
- PageStream, formerly known as Publishing Partner
- Prince XML, by YesLogic

- QuarkXPress
- QuickSilver, by Interleaf, acquired by BroadVision
- Ready, Set, Go! (software)
- Scenari, open source single-source publishing tool with support for chain publication
- Scribus, open source tool
- Xara Designer Pro X
- Xara Page & Layout Designer

Desktop Publishing Software for Mac

- Adobe InDesign
- Adobe PageMaker, discontinued in 2004
- Corel Ventura
- FlipB - Digital Publishing Software
- iCalamus
- IHDP Software- In House Digital Publishing Software
- iStudio Publisher - Desktop publishing and page layout software for Mac OS X
- Pages, by Apple, Inc.
- Ready,Set,Go!
- Scribus – page layout
- Print Shop, originally produced by Broderbund

Online Desktop Publishing Software

- Canva
- Fatpaint
- Lucidpress - Desktop publishing and page layout software that is web-based and collaborative

INTERNET AND ITS USES

The internet has intruded globally into everything than we could imagine. There are hardly people who do not rely on the internet for their daily life. Internet has emerged in such a way that we happen to use it to run our daily life in some way. The uses of Internet are endless; a few of them are as follows:

Education: Internet is a valuable source for a lot of information. Data and information related all fields are updated in the internet. Students can spend a few minutes over the internet to read their relevant study materials. Many students use internet for intense research on their projects.
Communication: With internet, communication has become better and easier. One can call and talk to someone over the internet. Video calls are an interesting option with communication through internet. Mailing is one another form of communication, which is widely used in daily corporate life.
Current Updates: Daily updates and current happenings are made available in the internet instantly. Internet is considered the real time hub for all updates about politics, sports, entertainment, science, business and many other fields.
Corporate Base: The corporate world relies on internet for file sharing, data transfer, internal communication and external communication; and many other purposes. In simple words, internet forms the base of the corporate today.
E-Commerce: Other than using internet for business purposes, a business itself can be started and accomplished through the internet. E-Commerce has lot of advantages like reaching the customers easily, giving a lot of information about the business, clearing customer queries instantly and making the payment also possible over the internet.

E –Learning

E-learning (also called electronic learning) is any type of learning that takes place through or with a computer and is primarily facilitated through the Internet but can also be accomplished with CD-ROMs and DVDs, streaming audio or video and other media. The purpose of e-learning is to allow people to learn for personal accomplishment or to earn a professional degree, without physically attending a traditional university or academic setting. Applied for all levels of schooling from grade school to graduate degrees, e-learning is versatile enough to accommodate all learning styles.

Types of E-Learning

There are a number of types of e-learning that depend on the amount of physical interaction. Entirely online e-learning occurs without any face-to face interaction. Course work and materials are distributed electronically through email, websites, online forums and/or CDs or DVD-ROMs. Combined learning uses a combination of Internet-directed instruction, as well as face-to-face interaction. Most traditional colleges and universities use combined learning as students learn in physical classrooms, with instruction augmented by online lessons. For those learning for personal accomplishment, e-learning can also use a combination of e-learning types, as they can be entirely self-directed, or they can use the assistance of an expert in their selected field.

Where to Learn

Because the only requirements for e-learning (in most cases) requires a computer with Internet access or a CD/DVD-ROM drive, e-learning students can learn from home, libraries, Internet cafes or any other location that has Internet access. This is why e-learning is a preferred option for those who work full time or part time and cannot afford to travel to a physical school. The ease of location with e-learning also makes it preferable to stay-at-home parents with young or special-needs children. E-learning can also save money in that e-learners do not have to pay for gas, vehicle repair or parking validation if they choose to remain at home while taking courses online. Ease of location is also beneficial to students who are home-schooled, as they can gain social interaction through online communications as well as educational materials.

Pace of Classes

Another benefit to e-learning is that it is self-directed, meaning that the e-learner sets the pace of her learning. Unlike traditional methods of education, e-learning allows a student to pace her educational needs with her comfort level. This is especially true when a person chooses to use e-learning for personal accomplishment. For those seeking a professional degree, there may be requirements and course work that must be completed by a certain time, but these deadlines are usually more flexible than the requirements made at traditional learning institutions.

Negative Aspects

The most controversial aspect of e-learning is for those who are seeking professional degrees. Some online learning institutions may not meet the academic standards set forth by private accreditation organizations. Accreditation standards are used to confirm a learning institution’s academic quality. This does not mean that an online institution that is not accredited has poor academic quality, but it can cause problems when an e-learner seeks to transfer credits from an online institution to a traditional educational facility. Another drawback to e-learning is that it can be difficult for individuals who are not primarily self-motivated. While self-directed learning has been appropriately praised for its versatility, it can be a trap for those who need the external motivations physical classrooms and instructors can provide.

E-Learning v. Traditional Costs
E-learning has also been praised as a lower-cost option for those seeking additional education. Costs for individual classes and learning institutions vary depending on location, degree or type of program, and area of study. Online universities generally charge the same way traditional universities do, by charging per credit hour. But also like traditional universities, scholarships, grants, and student loans are available as well. See the Resources list below for sites with information about e-learning costs by discipline and degree desired.

MODES OF LEARNING

Blended & flipped learning

The term '**blended' learning** is used to describe the combination and alignment of traditional and e-learning practices (Joint Information Systems Committee, 2004). This approach has been adopted to utilise the benefits afforded by each practice. A study by Kiviniemi (2014) found that a blended approach significantly increased students' performance on a health science course. Face-to-face time can be used more effectively and because digital resources can be made available for anytime anywhere access, learners are given more flexibility, which is particularly important when learners are balancing work and study commitments.

'Flipped learning' or the 'flipped classroom' is a blended learning approach whereby the traditional instructional approach is 'flipped' so that short video-lectures, narrated presentations or podcasts are viewed by the learner at home before the classroom-based activities. This means that the classroom element is repurposed into much more of a workshop style approach, focused around applying learning, questioning and clarifying concepts and engaging in interactive activities (Tucker 2012, p.82).

This approach needs as much preparation (if not more) than the traditional lecture but is particularly helpful for complex concepts. Learners are able to learn at their own pace, rerun lectures, skip over sections they know and read around the topic in their own time. The online resources are also available afterwards for revision and consolidation. This overcomes some of the disadvantages of the traditional lecture in which learners have to take notes, gain understanding from handouts and pay attention throughout. Class time can be used more effectively to ensure learners have understood and mastered the topic. Lecturers' classroom role changes to one of facilitator rather than didactic teacher. Rooms and equipment need to support the flipped approach and it involves a culture shift amongst the student and staff body.

Types of E-Learning

E-Learning enables the learners to learn anytime and anywhere. It enables the development of perfect learning content through the application of sound instructional design principles to perfectly analyze the basic requirements of learning as well as learning objectives.

Fundamentally, there are two categories of eLearning:

1. Synchronous
2. Asynchronous

Let us analyze them in detail

1. Synchronous – set time (phone/Internet classroom sessions)

Synchronous eLearning is real-time learning. In synchronous learning, the learners and the teacher are online and interact at the same time from different locations. They deliver and receive the learning resources via mobile, video conference, Internet or chat. In this type of learning the participants can share their ideas during the session and interact with each other and they get detailed queries and solutions. Synchronous eLearning is gaining popularity because of improved technology and Internet bandwidth capabilities.

Learning from the sources of:

- Virtual Classroom
- Audio and Video Conferencing
- Chat
- Webinars
- Application Sharing
- Messaging instantly

2. Asynchronous – student directed, self-paced learning

Asynchronous eLearning is pause-and-resume kind of learning. In this type of eLearning the learner and the teacher cannot be online at same time. Asynchronous eLearning may use technologies such as email, blogs, discussion forums, eBook's CDs, DVDs, etc. Learners may learn at any time, download documents, and chat with teachers & also with co-learners. In fact, many learners prefer asynchronous instead of synchronous learning because learners can take online courses to learn at their preferable time by not effecting their daily commitments.

Learning from the sources of:

- Self-paced online courses
- Discussion forums & groups
- Messages boards

Tools of E-Learning

Tool: Google Drive

What it does: Google Drive is our favorite form of cloud storage at LearnUpon. With teams working in diverse locations across the world, Google Drive provides a safe and central location where all team members can access the files they need at any time.

Why it's a great eLearning tool: Like LearnUpon, many eLearning teams have members that work remotely or travel frequently. Google Drive is useful for ensuring that team members have instant access to the most recent version of a file, avoiding the delay and potential confusion of email chains. Because files aren't located on individual desktops, you can be confident you're using the most recent version.

At LearnUpon, we find Google Drive a great location for storing the brochures and educational documents account managers may need to access from eLearning conferences and other remote locations. It's also a convenient place to store logos and branding materials that team members can access without needing to reach colleagues in different time zones.

Tool: Momentum

What it does: Momentum is a to-do list extension that can be used with the Google Chrome browser. Its main strength is that it's so easy to use.

To access your to-do list, simply open a new tab. When you first install the Momentum plugin, you'll be asked for your name, location, and a focus for the day, which will be used to personalize your to-do list later.

Why it's a great eLearning tool: Every eLearning professional needs an online to do list. Beauty and ease of use make Momentum our favorite.

Instead of hunting out a bookmark, simply pop open a new tab – one of the simplest actions we take every day.

That simplicity makes it all the more likely you'll add and track tasks, putting your to-do list to the best use. Momentum's backdrops are also gorgeous. The inclusion of a daily inspiring quote and update about local weather conditions makes it a great blend of the pretty and the useful.

Tool: Google Calendar
What it does: Google Calendar is our favorite eLearning tools for staying on top of team meetings and keeping up with customers and partners. With lots of great features, like the ability to add notes, send text notifications and schedule recurring reminders, Google Calendar makes sure we're on time and in the right meeting room at LearnUpon.

Why it's great for eLearning: From classes to client briefings, eLearning professionals must have their day fully organized. A big benefit of Google Calendar is it's widely used, so you won't need to worry about compatibility across devices and organizations. Recurring events are also great for eLearning, where training sessions can be scheduled weekly or semi-annually.

Virtual Learning

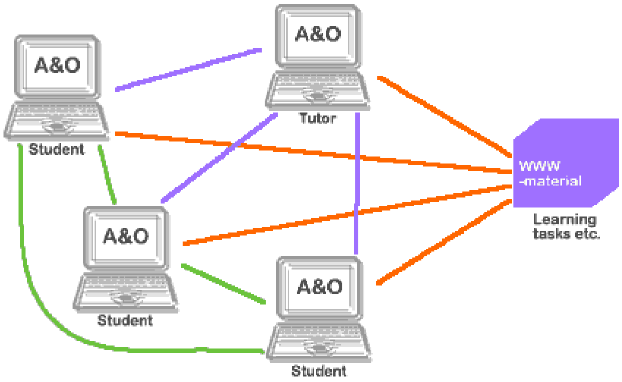
A **virtual learning** (**VL**) in educational technology is a Web-based platform for the digital aspects of courses of study, usually within educational institutions. VLEs typically:

- allow participants to be organized into cohorts, groups and roles
- present resources, activities and interactions within a course structure
- provide for the different stages of assessment
- report on participation; and have some level of integration with other institutional systems.

For those who edit them, VLEs may have a de facto role as authoring and design environments.[3] VLEs have been adopted by almost all higher education institutions in the English-speaking world.

Web Based Learning

Web-based learning has got much attention as being an incredible opportunity to study nowadays. Despite of its popularity the notion still remains unclear and confusing.



What is web-based learning? First of all it has many names. You have probably heard the following terms: online learning, e-learning, computer-based training, technology-based instruction etc. Generally the meaning and the basic concept of them are the same. Web-based learning is one way to learn, using web-based technologies or tools in a learning process. In other words, learner uses mainly computers to interact with the teacher, other students and learning material. Web-based learning consists of technology that supports traditional classroom training and online learning environments. "Pure" web-based courses are wholly based on computer and online possibilities. In this case all the communication and learning activities are done online. On the other hand, web-based courses may have some face-to-face sessions besides the distant learning tasks. In this case they are called blended courses as they blend web-based activities with face-to-face activities.

Web-based learning can be also formal or informal. Formal web-based learning is purposed and learning activities are organised by teachers. Informal learning takes place while you are searching material from the Internet. It is self-paced, depending on your goals and ambition to learn.

Teleconferencing

A **teleconference** or **teleseminar** is the live exchange and mass articulation of information among several persons and machines remote from one another but linked by a telecommunications system. Terms such as audio conferencing, telephone conferencing and phone conferencing are also sometimes used to refer to teleconferencing.

The telecommunications system may support the teleconference by providing one or more of the following: audio, video, and/or data services by one or more means, such as telephone, computer, telegraph, teletypewriter, radio and television.

Internet teleconferencing

Internet teleconferencing includes internet telephone conferencing, videoconferencing, web conferencing, and augmented reality conferencing.

Internet telephony involves conducting a teleconference over the Internet or a Wide Area Network. One key technology in this area is Voice over Internet Protocol (VOIP). Popular software for personal use includes Skype, Google Talk, Windows Live Messenger and Yahoo! Messenger.

A working example of an augmented reality conferencing was demonstrated at the Salone di Mobile in Milano by AR+RFID Lab. is another AR teleconferencing tool.

Video Conferencing

A video conference is a live, visual connection between two or more people residing in separate locations for the purpose of communication. At its simplest, video conferencing provides transmission of static images and text between two locations. At its most sophisticated, it provides transmission of full-motion video images and high-quality audio between multiple locations. Consumer services -- like Apple's FaceTime, Google's Hangouts and Microsoft's Skype -- have made video conferencing ubiquitous on desktops and mobile devices that have an embedded camera. In the business world, desktop video conferencing is a core component of unified communications applications and Web conferencing services, while cloud-based virtual meeting room services enable organizations to deploy video conferencing with minimal infrastructure investment.

For businesses, the tangible benefits of video conferencing include lower travel costs -- especially for employee training -- and shortened project times as a result of improved communications among team members.

The intangible benefits of video conferencing include more efficient meetings with the exchange of non-verbal communications and a stronger sense of community among business contacts, both within and between companies, as well as with customers. On a personal level, the face-to-face connection adds non-verbal communication to the exchange and allows participants to develop a stronger sense of familiarity with individuals they may never actually meet in person.

ADVANTAGES OF VIDEO CONFERENCING

1. LESSER TRAVELS
Video conferencing has made it easier for people who had to travel frequently for conferences. As this technology gives facility to conduct conference at the comfort of your home or office, a large number of business trips have been cut short.

2. ANYTIME CONFERENCE
There is no time constraint to conduct a video conference. It can be conducted whenever there is a requirement. Even if the members are at different parts of the world, all they have to do is login from their machines.

3. BETTER COMMUNICATION
It is possible to communicate through images, texts, audio and video in video conferencing. This gives an added advantage of better clarity of the idea being conveyed. Screen sharing is also possible in case further explanation is necessary.

4. TIME AND MONEY SAVER
As discussed above, video conferencing has reduced the need for business trips. Previously a lot of money was spent on the travel, food and accommodation. Traveling long distances just for a meeting would also mean a lot of time waste. All these have been addressed with this facility which helps you attend a meeting anywhere.

5. INCREASES PRODUCTIVITY
Fast and better communication contributes to better productivity. It creates a favorable working environment where people can conduct a conference whenever necessary. So there is no confusion about ideas since everybody can login from wherever they are and be updated.

6. INCREASED RETURN
Lesser travels and time saving would result in quick and increased return for the company. This ensures a better growth rate too.

DISADVANTAGES OF VIDEO CONFERENCING

1. NO PERSONAL INTERACTION
Nothing would replace a personal interaction like a smile or handshake. In business dealings it is important to win trust and respect of the other party. A

video conference may prove insufficient to achieve this. It is better to meet personally in such cases.

2. TECHNICAL PROBLEMS
Working with laptops is always associated with technical problems like hardware failure, network connection issues, software issues etc. Environmental changes also affect the connectivity. It will be a loss if some problem arises at the crucial moment.

3. COSTLY SET UP
It can be costly for small companies to set up video conference in the office. There are many simple and advanced features that come with video conferencing. While the simple ones are less expensive, the advanced ones cost a little too much.

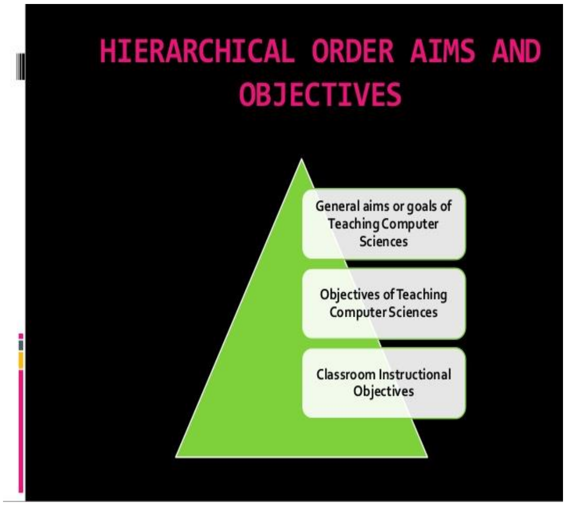
4. MORE WORKING HOURS
Even though it is easy to conduct the conference at any time, it is practically difficult for people working in different time zones. After working the whole day in office there may be important updates to be given to the team members working in the next shift at a different location. This would mean spending the evening in conference thus making you actually work more hours than paid for.

5. DELAY IN RESPONSE
Even though participants of the conference can be from across the globe, there are some difficulties faced due to this long distance. A slight delay between responses that come from one side to the other side of the world is a common thing. You might have noticed this if you have attended international calls.

6. COVERAGE OF THE CAMERA
The entire room may not be visible to people sitting at other locations due to the lesser coverage of the camera. This becomes a problem if there are a large number of people at one location.

Unit II: Objectives of Teaching Computer Science and Micro Teaching

They are desirable learning or **teaching** outcomes.



♣ In fact, classroom instructional **objectives**, **objectives of teaching Computer Sciences** at a particular or entire stage of school education.

♣The general **aims** or goals of **teaching Computer Sciences** represent a hierarchical order

Aims, Objectives & Importance of Teaching Computer Science

Aims to produce programmers equipped with an understanding of

- fundamental computational concepts underlying most programming languages
- a range of problem solving techniques using computers
- the role of programming within the overall software development process
- attitudes and working practices appropriate for a professional programmer and skills supporting
- the solution of small problems using a programming language
- the clear expression of solutions at different levels of abstraction
- independent and self-motivated study in Computing Science.

Aims And Objectives Of Computer Education

Computers have turn into a common and required part of life in present's society, making computer education very important for children. Young kids will normally start to show an interest in the house PC by their toddler time. While it is might is an excellent idea to start introducing your toddler to the computer in extremely small sessions, most kids can begin to learn and know a computer's functionality in their kindergarten age?

Kindergarten age kids can study to turn on the computer by themselves and will speedily learn to control the mouse. Easy games that teach and support

essential school readiness skills are excellent for this age. Computer education for kindergarten age kids should be limited to little sessions of about thirty minutes a few times in a week.
Lots of childcare services give computer time as component of their weekly syllabus for preschoolers. Prearranged games and activities give young kids a chance to look at the way a computer works. Games that need dragging items across the monitor are outstanding for building mouse skills in student users. Choose age-appropriate websites and software that involve alphabet and color acknowledgment, counting, shapes, or small stories that are read clearly. Actions that feature music are too pleasant for a preschooler computer time.

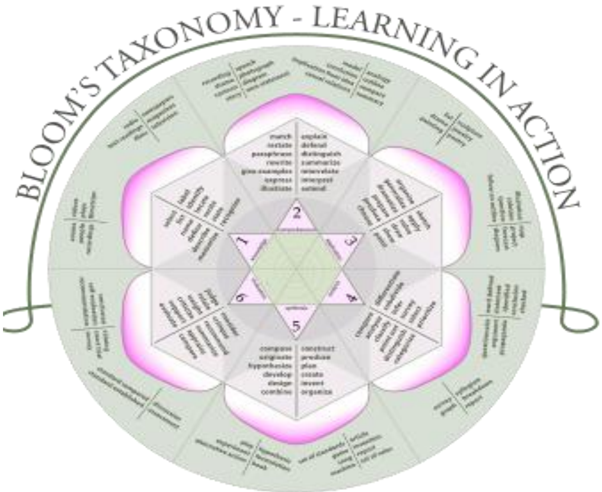
Kindergartners are usually still exploring the ABC of computer use and will most likely do finest with activities that support easy skills. As kids become more relaxed with the computer, more difficult games and activities can be introduced to them. Computer education for preschoolers normally consists of small sessions of no extra than an hour, playing games that associate with their classroom education material.

By first grade, kids have typically gained a fine understanding of how to use mouse and they're learning to utilize keyboard letters to kind. Games like Typing teacher for children can help young kids become fast and professional computer users. Early elementary age kids are prepared to move beyond simple support and skill drill activities to the numerous different function of a computer.

Initial through third graders must use the computer as an extra for their classroom work. A scholar studying on planets and stars can use the internet to look for pictures and details about constellation. A task about Africa can take in an investigation for videos of African wild animals. Let your youngster to work on his own, however stay close by to stop access to unsuitable content and to answer on any questions.

Software programs that let kids to make, like a drawing or publishing set designed especially for children, can boost imagination along with provided that experience to technology. Score level skills can moreover be practiced and improved with reading, math, and spelling computer games. There are several kid-friendly websites that offer search engines, games, and communication opportunities.

Bloom's taxonomy



Bloom's taxonomy is a set of three hierarchical models used to classify educational learning objectives into levels of complexity and specificity. The three lists cover the learning objectives in cognitive, affective and sensory domains. The cognitive domain list has been the primary focus of most traditional education and is frequently used to structure curriculum learning objectives, assessments and activities.

The models were named after Benjamin Bloom, who chaired the committee of educators that devised the taxonomy. He also edited the first volume of the standard text, *Taxonomy of Educational Objectives: The Classification of Educational Goals*[1]

History

Although named after Bloom, the publication of *Taxonomy of Educational Objectives* followed a series of conferences from 1949 to 1953, which were designed to improve communication between educators on the design of curricula and examinations.

The first volume of the taxonomy, *Handbook I: Cognitive*[1] was published in 1956, and in 1964 *Handbook II: Affective*. A revised version of the taxonomy for the cognitive domain was created in 2001.

The cognitive domain (knowledge-based)

In the original version of the taxonomy, the cognitive domain is broken into the following six levels of objectives. In the 2001 revised edition of Bloom's taxonomy, the levels are slightly different: Remember, Understand, Apply, Analyze, Evaluate, Create (rather than Synthesize).

Knowledge

Knowledge involves recognizing or remembering facts, terms, basic concepts, or answers without necessarily understanding what they mean. Its characteristics may include:

- Knowledge of specifics—terminology, specific facts
- Knowledge of ways and means of dealing with specifics—conventions, trends and sequences, classifications and categories, criteria, methodology
- Knowledge of the universals and abstractions in a field—principles and generalizations, theories and structures

Example: Name three common varieties of apple.

Comprehending

Comprehension involves demonstrating understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating the main ideas.

Example: Compare the identifying characteristics of a Golden Delicious apple with a Granny Smith apple.

Applying

Applying involves using acquired knowledge—solving problems in new situations by applying acquired knowledge, facts, techniques and rules. Learners should be able to use prior knowledge to solve problems, identify connections and relationships and how they apply in new situations.

Example: Would apples prevent scurvy, a disease caused by a deficiency in vitamin C?

Analyzing

Analyzing involves examining and breaking information into component parts, determining how the parts relate to one another, identifying motives or causes, making inferences, and finding evidence to support generalizations. Its characteristics include:

- Analysis of elements
- Analysis of relationships
- Analysis of organization

Example: List four ways of serving foods made with apples and explain which ones have the highest health benefits. Provide references to support your statements.

Synthesizing

Synthesizing involves building a structure or pattern from diverse elements; it also refers to the act of putting parts together to form a whole. Its characteristics include:

- Production of a unique communication
- Production of a plan, or proposed set of operations
- Derivation of a set of abstract relations

Example: Convert an "unhealthy" recipe for apple pie to a "healthy" recipe by replacing your choice of ingredients. Explain the health benefits of using the ingredients you chose vs. the original ones.

Evaluating

Evaluating involves presenting and defending opinions by making judgments about information, the validity of ideas, or quality of work based on a set of criteria. Its characteristics include:

- Judgments in terms of internal evidence
- Judgments in terms of external criteria

Example: Which kinds of apples are best for baking a pie, and why?

The affective domain (emotion-based)

Skills in the affective domain describe the way people react emotionally and their ability to feel other living things' pain or joy. Affective objectives typically target the awareness and growth in attitudes, emotion, and feelings.

There are five levels in the affective domain moving through the lowest-order processes to the highest.

Receiving

The lowest level; the student passively pays attention. Without this level, no learning can occur. Receiving is about the student's memory and recognition as well.

Responding

The student actively participates in the learning process, not only attends to a stimulus; the student also reacts in some way.

Valuing

The student attaches a value to an object, phenomenon, or piece of information. The student associates a value or some values to the knowledge they acquired.

Organizing

The student can put together different values, information, and ideas, and can accommodate them within his/her own schema; the student is comparing, relating and elaborating on what has been learned.

Characterizing

The student at this level tries to build abstract knowledge.

The psychomotor domain (action-based)

Skills in the psychomotor domain describe the ability to physically manipulate a tool or instrument like a hand or a hammer. Psychomotor objectives usually focus on change and/or development in behavior and/or skills.

Bloom and his colleagues never created subcategories for skills in the psychomotor domain, but since then other educators have created their own psychomotor taxonomies. Simpson (1972) proposed the following levels:

Perception

The ability to use sensory cues to guide motor activity: This ranges from sensory stimulation, through cue selection, to translation.

Examples: Detects non-verbal communication cues. Estimate where a ball will land after it is thrown and then moving to the correct location to catch the ball. Adjusts heat of the stove to correct temperature by smell and taste of food. Adjusts the height of the forks on a forklift by comparing where the forks are in relation to the pallet.

Key words: chooses, describes, detects, differentiates, distinguishes, identifies, isolates, relates, selects.

Set

Readiness to act: It includes mental, physical, and emotional sets. These three sets are dispositions that predetermine a person's response to different situations (sometimes called mindsets). This subdivision of psychomotor is closely related with the "responding to phenomena" subdivision of the affective domain.

Examples: Knows and acts upon a sequence of steps in a manufacturing process. Recognizes his or her abilities and limitations. Shows desire to learn a new process (motivation).

Key words: begins, displays, explains, moves, proceeds, reacts, shows, states, volunteers.

Guided response

The early stages of learning a complex skill that includes imitation and trial and error: Adequacy of performance is achieved by practicing.

Examples: Performs a mathematical equation as demonstrated. Follows instructions to build a model. Responds to hand-signals of the instructor while learning to operate a forklift.

Key words: copies, traces, follows, react, reproduce, responds.

Mechanism

The intermediate stage in learning a complex skill: Learned responses have become habitual and the movements can be performed with some confidence and proficiency.

Examples: Use a personal computer. Repair a leaking tap. Drive a car.

Key words: assembles, calibrates, constructs, dismantles, displays, fastens, fixes, grinds, heats, manipulates, measures, mends, mixes, organizes, sketches.

Complex overt response

The skillful performance of motor acts that involve complex movement patterns: Proficiency is indicated by a quick, accurate, and highly coordinated performance, requiring a minimum of energy. This category includes performing without hesitation and automatic performance. For example, players will often utter sounds of satisfaction or expletives as soon as they hit a tennis ball or throw a football because they can tell by the feel of the act what the result will produce.

Examples: Maneuvers a car into a tight parallel parking spot. Operates a computer quickly and accurately. Displays competence while playing the piano.

Key words: assembles, builds, calibrates, constructs, dismantles, displays, fastens, fixes, grinds, heats, manipulates, measures, mends, mixes, organizes, sketches. (Note: The key words are the same as in mechanism, but will have adverbs or adjectives that indicate that the performance is quicker, better, more accurate, etc.)

Adaptation

Skills are well developed and the individual can modify movement patterns to fit special requirements.

Examples: Responds effectively to unexpected experiences. Modifies instruction to meet the needs of the learners. Performs a task with a machine that was not originally intended for that purpose (the machine is not damaged and there is no danger in performing the new task).

Key words: adapts, alters, changes, rearranges, reorganizes, revises, varies.

Origination

Creating new movement patterns to fit a particular situation or specific problem: Learning outcomes emphasize creativity based upon highly developed skills.

Examples: Constructs a new set or pattern of movements organized around a novel concept or theory. Develops a new and comprehensive training program. Creates a new gymnastic routine.

Key words: arranges, builds, combines, composes, constructs, creates, designs, initiate, makes, originates.

Definition of knowledge

In the appendix to *Handbook I*, there is a definition of knowledge which serves as the apex for an alternative, summary classification of the educational goals. This is significant as the taxonomy has been called upon significantly in other fields such as knowledge management, potentially out of context. "Knowledge, as defined here, involves the recall of specifics and universals, the recall of methods and processes, or the recall of a pattern, structure, or setting.

Computer Science Teaching at Primary, secondary and higher secondary levels

Computers are omnipresent, and today most children learn how to interact with icons and apps before they learn how to read. However, using computers and understanding how they operate are two different things, which is why schools employ educators trained to teach computer science to their students.

By definition, computer science is a field that focuses on the understanding and design of computers, and computational processes. While some computer scientists are concerned with algorithms, others focus on the development and implementation of hardware and software. At the college and university levels, computer science overlaps with several allied fields, including information technology and computer engineering.

Those with an interest to teach computer science can look forward to an abundance of job openings, starting at the high school level. As technology becomes an increasingly significant part of the world, employment opportunities related to academics will continue to grow, especially for those who possess an advanced degree in the field.

HOW CAN I BECOME AN ELEMENTARY OR MIDDLE SCHOOL COMPUTER SCIENCE TEACHER?

While computer science is not taught at the elementary or middle school levels as a stand-alone class, many schools employ media studies teachers to serve as a school’s library resource teacher, especially at the elementary level. In many respects, media studies is a misleading term for these teachers, since they typically do not teach concepts that overlap with media studies at the postsecondary level. They do, however, educate students on basic computing skills, and in some cases, offer introductory level lessons in computer science.

An elementary or middle school media studies teacher may also introduce students to basic computer functions and basic programming languages, such as HTML. Despite a growing demand to incorporate computer science at an earlier level, the elementary and middle school curriculum nearly always focuses on teaching students how to use computers, rather than teaching students how computers work.

Individuals with an interest in teaching computer science or computer-related topics at an elementary or middle school must complete the following:

HOW CAN I BECOME A HIGH SCHOOL COMPUTER SCIENCE TEACHER?

Not surprisingly, there is a growing demand to provide computer science courses to high school students. Both industry leaders and organizations, like the CSTA (Computer Science Teachers Association), continue to make compelling arguments in favor of offering computer science courses as a core part of the high school curriculum. While the subject is available as an elective at various high schools across the nation, reports reveal that only 25 percent of K-12 schools in the United States offer computer science courses, while 22 states do not permit computer science education to count towards a student's high school diploma.

By 2014, close to half of all Zambia. provinces had introduced policies to allow computer science courses to count as mathematics or science credits at the high school level. Several more provinces are now in the process of introducing legislation that would integrate computer science into schools even further. Despite the intense lobbying from industry, there is still a long way to go. For example, not all computer science teachers have a clear pathway to gaining certification in the field, with requirements and options that vary according to state.

In most provinces, computer science courses are offered by teachers who hold a bachelor's degree in mathematics or science, are certified to teach in their state, and simply have a passion for the field

Microteaching

A teacher training and faculty development technique whereby the teacher reviews a recording of a teaching session, in order to get constructive feedback from peers and/or students about what has worked and what improvements can be made to their teaching technique. Micro-teaching was invented in the mid-1960s at Stanford University by Dwight W. Allen, and has subsequently been used to develop educators in all forms of education.

In the original process, a teacher was asked to prepare a short lesson (usually 20 minutes) for a small group of learners who may not have been his/her own students. This was then recorded on video. After the lesson, the teacher, teaching colleagues, a master teacher and the students together viewed the videotape and commented on what they saw happening, referencing the teacher's learning objectives. Watching the video and getting comments from colleagues and students provide teachers with an often intense "under the microscope" view of their teaching.

A review of the evidence for micro-teaching, undertaken by John Hattie as part of his Visible Learning project, found it was an effective method for improving student outcomes

Introduction

Microteaching is a technique aiming to prepare teacher candidates to the real classroom setting (Brent & Thomson, 1996). Microteaching can also defined as a teaching technique especially used in teachers' pre-service education to train them systematically by allowing them to experiment main teacher behaviors. By the help of this technique, teacher candidates can experiment and learn each of the teaching skills by breaking them into smaller parts and without encountering chaotic environment of the crowded classes. While instilling teaching skills in students during microteaching, reciprocal negotiation of the students actively presenting and watching about the performances can make great contribution to the acquisition of the skills (Taşdemir, 2006). Wilkinson (1996), emphasizes that teacher candidates can experience real teaching and teaching rules with the help of this method. This method offers teachers opportunities for discovering and reflecting on both their own and others' teaching styles and enables them to learn about new teaching techniques (Wahba, 1999). Pre-service teacher can benefit to a great extent from microteaching applications. Firstly, they reveal teaching facts; and roles of the teacher (Amobi, 2005; Hawkey, 1995; Kpanja, 2001; Wilkinson, 1996); help pre-service teachers to see the importance of planning and taking decisions (Gess-Newsome & Lederman, 1990); enable them to develop and improve their teaching skills (Benton-Kupper, 2001).

Microteaching technique is an application in which video recordings have been made possible as a result of developing technology. Audio and visual technology is an effective and reflective tool in preparing pre-service teachers to the profession of teaching. Video recordings provide pre-service teachers with the chance of evaluating themselves by engaging them in more experiences and configurations (Jensen et al., 1994). Sherin (2000) indicates that video recordings affect the perspectives of teachers in education process. Cunningham & Benedetto (2002) emphasize that video tools support the reflective learning, and Spurgeon & Bowen (2002) stress that by the help of these tools, the problems that may occur in education process can be observed and defined. Farris (1991) states that this method increases the confidence and raises the awareness of personal skills. Selçuk (2001) indicates that video recordings can not only be used for demonstrating model teacher behaviours but can also be used for the analysis of microteaching. Using video recording method in microteaching applications contributes to the professional development of pre-service teachers by identifying strengths and weaknesses and improves their competencies (Tok, 2007).

Techniques

Since its inception in 1963, micro-teaching has become an established teacher-training procedure in many universities and school districts. This training procedure is geared towards simplification of the complexities of the regular teaching-learning process. Class size, time, task, and content are scaled down to provide optimal training environments. The supervisor demonstrates the skill to be practiced. This may be live demonstration, or a video presentation of the skill. Then, the group members select a topic and prepare a lesson of five to ten minutes. The teacher trainee then has the opportunity to practice and evaluate his use of the skills. Practice takes the form of a ten-minute micro-teaching session in which five to ten pupils are involved.

In more recent years, the easy availability of recording equipment and the use of social media for dissemination have made micro-teaching more accessible

Verbal and Non-Verbal Communications

The sharing of information between individuals by using speech. Individuals working within a business need to effectively use **verbal communication** that employs readily understood spoken words, as well as ensuring that the enunciation, stress and tone of voice with which the words are expressed is appropriate.

A vocal element of **nonverbal communication** is paralanguage, which is the vocalized but not **verbal** part of a spoken message, such as speaking rate, volume, and pitch. Nonvocal elements of **nonverbal communication** include body language such as gestures, facial expressions, and eye contact.

How to Improve Verbal and Non-verbal Communication?

Verbal communication is enhanced when a person is an effective listener. Listening doesn’t simply mean hearing; it necessitates understanding another person’s point of view. Take the time to think before you speak to ensure that you articulate yourself clearly. Let other people interject and have the floor. Allow time for reflection on the subject at hand.

Watching other people's body language, facial expressions and intonations, and being conscious of your own physicality and feelings can enhance non-verbal communication. Record yourself with both a video camera and an audio recorder to see how you communicate non-verbally. Are your gestures matching your words, or giving away what you're really thinking? Being aware of what we say and how we say it is the first step to successful communication. The ability to adapt quickly to the situation and form of communication at hand is a skill that people continue to hone for a lifetime.

Examples of non-verbal communication of this type include shaking hands, patting the back, hugging, pushing, or other kinds of touch. Other forms of non-verbal communication are facial expressions, gestures, and eye contact. When someone is talking, they notice changes in facial expressions and respond accordingly.

Differences between Verbal and Non-Verbal Communication

It includes sounds, words, or speaking. Tone of voice, volume, and pitch are all ways to effectively communicate verbally. Nonverbal communication includes gestures, facial expressions, body movement, timing, touch, and anything else done without speaking. People seem to notice nonverbal communication more than verbal.

Professional Development Skills for Modern Teachers

When schools are looking to hire a teacher, there are a few basic requirements that they are looking for: A College degree, experience working with children, and, of course, patience. Teachers need a variety of **professional development** skills along with knowledge of their subject matter and experience in order to be an effective teacher.

Likewise, as the rapid developments in technology infuse into our lives, they affect the way students learn and the way teachers teach. Modern teachers need to be competent in not only basic skills, but new skill sets.

Here are 15 of the many 21st-century **professional development** skills, or as we like to call it, “Modern skills” that today’s teachers should possess.

1. <u>Professional Development</u>: Adaptability

In this modern, digital age, teachers need to be flexible and be able to adapt to whatever is thrown their way. New technologies are developed every day that can change the way students learn, and the way teachers teach. Likewise, administrators are changing and updating expectations and learning standards. Being able to adapt is a skill that every modern teacher must have. If it’s being able to adapt to the way students learn, the behavior their classroom exhibits, or their lesson plans, it is a definitely a trait that is a must-have.

2. Confidence

Every teacher needs to have confidence, not only in themselves but in their students and their colleagues. A confident person inspires others to be confident, and a teacher’s confidence can help influence others to be a better person.

3. Communication

Being able to communicate with not only your students but with parents and staff is an essential skill. Think about it: Almost all of a teacher’s day is spent communicating with students and colleagues so it is crucial to be able to talk clear and concise in order to get your point across.

4. Team Player

Part of being a teacher is being able to work together as part of a team or a group. When you work together as a team, it provides students with a better chance to learn and have fun. Networking with other teachers (even virtually) and solving problems together will only lead to success. Doing so fosters a sense of community not only in your own classroom, but school-wide as well.

5. Continuous Learner

Teaching is a lifelong learning process. There is always something to learn when you are teacher. The world is always changing, along with the curriculum and educational technology, so it’s up to you, the teacher, to keep up with it. A teacher who is always willing to go that extra mile to learn will always be an effective, successful teacher.

6. Imaginative

The most effective tool a teacher can use is their imagination. Teachers need to be creative and think of unique ways to keep their students engaged in learning, especially now that many states have implemented the Common Core Learning Standards into their curriculum. Many teachers are saying that these standards are taking all of the creativity and fun out of learning, so teachers are finding imaginative ways to make learning fun again.

7. Leadership
An effective teacher is a mentor and knows how to guide her students in the right direction. She leads by example and is a good role model. She encourages students and leads them to a place of success.

8. Organization
Modern teachers have the ability to organize and prepare for the unknown. They are always ready for anything that is thrown their way. Need to go home sick? No problem, they have a substitute folder all ready to go. Studies show that organized teachers lead more effective learning environments. So it is even more imperative to be organized if you want higher-achieving students.

9. Innovative
A modern teacher is willing to try new things, from new educational apps to teaching skills and electronic devices. Being innovative means not only trying new things, but questioning your students, making real-world connections and cultivating a creative mindset. It's getting your students to take risks and having students learn to collaborate.

10. Commitment
While being committed to your job is a traditional teaching skill, it is also a modern one. A modern teacher needs to always be engaged in their profession. The students need to see that their teacher is present and dedicated to being there for them.

11. Ability to Manage Online Reputation
This 21^{st}-century, modern teaching skill is definitely a new one. In this digital age most, if not all, teachers are online, which means they have an "Online reputation." Modern teachers need to know how to manage their online reputation and which social networks are OK for them to be on. LinkedIn is a professional social network to connect with colleagues, but Snapchat or any other social networking site where students visit, is probably not a good idea.

12. Ability to Engage
Modern teachers know how to find engaging resources. In this digital age, it is essential to find materials and resources for students that will keep them interested. This means keeping up to date on new learning technologies and apps, and browsing the web and connecting to fellow teachers. Anyway that you can engage students and keep things interesting is a must.

13. Understanding of Technology
Technology is growing at a rapid pace. In the past five years alone we have seen huge advancements and we will continue to see it grow. While it may be hard to keep up with it, it is something that all modern teachers need to do. Not only do you just need to understand the latest in technology, but you must also know which digital tools is right for your students. It's a process that may take time but will be greatly influential in the success of your students.

14. Know When to Unplug
Modern teachers know when it's time to unplug from social media and just relax. They also understand that the teacher burnout rate is high, so it's even more critical for them to take the time to slow down and take a moment for themselves. They also know when it's time to tell their students to unplug and slow down. They give their students time each day for a brain break and let them kick their heels up and unwind.

15. Ability to Empower
Teachers inspire, that's just one of the qualities that come along with the title. Modern educators have the ability to empower students to think critically, be innovative, creative, adaptable, passionate, and flexible. They empower them to be able to solve problems, self-direct, self-reflect, and lead. They give them the tools both digital and knowledgeable to succeed, not only in school but in life.

Blackboard

A blackboard (also known as a chalkboard) is a reusable writing surface on which text or drawings are made with sticks of calcium sulfate or calcium carbonate, known, when used for this purpose, as chalk. Blackboards were originally made of smooth, thin sheets of black or dark grey slate stone.

Design

Students writing on a blackboard in a village school in Laos, 2007

A modern chalkboard, 2014.

A blackboard can simply be a board painted with matte dark paint (usually black, occasionally dark green). Matte black plastic sign material (known as ‘closed-cell PVC foamboard’) is also used to create custom chalkboard art. A more modern variation consists of a coiled sheet of plastic drawn across two parallel rollers, which can be scrolled to create additional writing space while saving what has been written. The highest grade blackboards are made of a rougher version porcelain enamelled steel (black, green, blue or sometimes other colours). Porcelain is very hard wearing and blackboards made of porcelain usually last 10–20 years in intensive use.

Manufacturing of slate blackboards began by the 1840s. Green chalkboards, generally made of porcelain enamel on a steel base, first appeared in the 1960s.

Magnetic blackboard used for play and learning at the children’s museum, Kitchener, Canada (The Museum), 2011

Teacher explaining the decimal system of weights using a blackboard, Guinea-Bissau, 1974

Lecture theatres may contain a number of blackboards in a grid arrangement. The lecturer then moves boards into reach for writing and then moves them out of reach, allowing a large amount of material to be shown simultaneously.

The chalk marks can be easily wiped off with a damp cloth, a sponge or a special blackboard eraser usually consisting of a block of wood covered by a felt pad. However, chalk marks made on some types of wet blackboard can be difficult to remove. Blackboard manufacturers often advise that a new or newly resurfaced blackboard be completely covered using the side of a stick of chalk and then that chalk brushed off as normal to prepare it for use.

Unit III: Planning and Techniques in the Teaching of Computer Science

A lesson plan is a teacher's detailed description of the course of instruction or "learning trajectory" for a lesson. A daily lesson plan is developed by a teacher to guide class learning. Details will vary depending on the preference of the teacher, subject being covered, and the needs of the students.

Lesson plan

A lesson plan is a teacher's detailed description of the course of instruction or "learning trajectory" for a lesson. A daily lesson plan is developed by a teacher to guide class learning. Details will vary depending on the preference of the teacher, subject being covered, and the needs of the students. There may be requirements mandated by the school system regarding the plan. A lesson plan is the teacher's guide for running a particular lesson, and it includes the goal (what the students are supposed to learn), how the goal will be reached (the method, procedure) and a way of measuring how well the goal was reached (test, worksheet, homework etc.)

Development

While there are many formats for a lesson plan, most lesson plans contain some or all of these elements, typically in this order:

- *Title* of the lesson
- *Time* required to complete the lesson
- List of required *materials*
- List of *objectives*, which may be *behavioral objectives* (what the student can *do* at lesson completion) or *knowledge objectives* (what the student *knows* at lesson completion)

- The *set* (or lead-in, or bridge-in) that focuses students on the lesson's skills or concepts—these include showing pictures or models, asking leading questions, or reviewing previous lessons
- An *instructional component* that describes the sequence of events that make up the lesson, including the teacher's instructional input and, where appropriate, guided practice by students to consolidate new skills and ideas
- *Independent practice* that allows students to extend skills or knowledge on their own
- A *summary*, where the teacher wraps up the discussion and answers questions
- An *evaluation* component, a test for mastery of the instructed skills or concepts—such as a set of questions to answer or a set of instructions to follow
- A *risk assessment* where the lesson's risks and the steps taken to minimize them are documented
- An *analysis* component the teacher uses to reflect on the lesson itself—such as what worked and what needs improving
- A *continuity* component reviews and reflects on content from the previous lesson

Lesson Plan Phases

According to Gini Cunningham, there are eight lesson plan phrases that are designed to provide "many opportunities for teachers to recognize and correct students' misconceptions while extending understanding for future lessons." These phases are: Introduction, Foundation, Brain Activation, Body of New Information, Clarification, Practice and Review, Independent Practice, and Closure.

Herbartian Approach: John Fedrick Herbert (1776-1841)

1. Preparation/Instruction: It pertains to preparing and motivating children to the lesson content by linking it to the previous knowledge of the student, by arousing curiosity of the children and by making an appeal to their senses. This prepares the child's mind to receive new knowledge. "To know where the pupils are and where they should try to be are the two essentials of good teaching." Lessons may be started in the following manner: a. Two or three interesting but relevant questions b. Showing a picture/s, a chart or a model c. A situation Statement of Aim: Announcement of the focus of the lesson in a clear, concise statement such as "Today, we shall study the..."

2. Presentation/Development: The actual lesson commences here. This step should involve a good deal of activity on the part of the students. The teacher will take the aid of various devices, e.g., questions, illustrations, explanation, expositions, demonstration and sensory aids, etc. Information and knowledge can be given, explained, revealed or suggested. The following principles should be kept in mind.

   a. Principle of selection and division: This subject matter should be divided into different sections. The teacher should also decide as to how much he is to tell and how much the pupils are to find out for themselves.

   b. Principle of successive sequence: The teacher should ensure that the succeeding as well as preceding knowledge is clear to the students.

   c. Principle of absorption and integration: In the end separation of the parts must be followed by their combination to promote understanding of the whole.

3. Association comparison: It is always desirable that new ideas or knowledge be associated to daily life situations by citing suitable examples and by drawing comparisons with the related concepts. This step is important when we are establishing principles or generalizing definitions.
4. Generalizing: This concept is concerned with the systematizing of the knowledge learned. Comparison and contrast lead to generalization. An effort should be made to ensure that students draw the conclusions themselves. It should result in student's own thinking, reflection and experience.
5. Application: It requires a good deal of mental activity to think and apply the principles learn to new situations. Knowledge, when it is put to use and verified, becomes clear and a part of the student's mental make-up.
6. Recapitulation: Last step of the lesson plan, the teacher tries to ascertain whether the students have understood or grasped the subject matter or not. This is used for assessing/evaluating the effectiveness of the lesson by asking students questions on the contents of the lesson or by giving short objectives to test the student's level of understanding; for example, to label different parts on a diagram, etc.

A well-developed lesson plan

A well-developed lesson plan reflects the interests and needs of students. It incorporates best practices for the educational field. The lesson plan correlates with the teacher's philosophy of education, which is what the teacher feels is the purpose of educating the students.

Secondary English program lesson plans, for example, usually center around four topics. They are literary theme, elements of language and composition, literary history, and literary genre. A broad, thematic lesson plan is preferable, because it allows a teacher to create various research, writing, speaking, and reading assignments. It helps an instructor teach different literature genres and incorporate videotapes, films, and television programs. Also, it facilitates teaching literature and English together. Similarly, history lesson plans focus on content (historical accuracy and background information), analytic thinking, scaffolding, and the practicality of lesson structure and meeting of educational goals. School requirements and a teacher's personal tastes, in that order, determine the exact requirements for a lesson plan.

Unit plans follow much the same format as a lesson plan, but cover an entire unit of work, which may span several days or weeks. Modern constructivist teaching styles may not require individual lesson plans. The unit plan may include specific objectives and timelines, but lesson plans can be more fluid as they adapt to student needs and learning styles.

Unit Planning is the proper selection of learning activities which presents a complete picture. Unit planning is a systematic arrangement of subject matter. Samford "A unit plan is one which involves a series of learning experiences that are linked to achieve the aims composed by methodology and contents". Dictionary of Education:" A unit is an organization of various activities, experiences and types of learning around a central problem or purpose developed cooperatively by a group of pupils under a teacher leadership involving planning, execution of plans and evaluation of results".

Criteria of a good Unit Plan

1. Needs, capabilities, interest of the learner should be considered.
2. Prepared on the sound psychological knowledge of the learner.
3. Provide a new learning experience; systematic but flexible.
4. Sustain the attention of the learner till the end.
5. Related to social and Physical environment of the learner.
6. Development of learner's personality.

It is important to note that lesson planning is a thinking process, not the filling in of a lesson plan template. Lesson plan envisaged s a blue print, guide map for action, a comprehensive chart of classroom teaching-learning activities, an elastic but systematic approach for the teaching of concepts, skills and attitudes.

Setting objectives

The first thing a teacher does is to create an objective, that is, a statement of purpose for the whole lesson. An objective statement itself should answer what students will be able to do by the end of the lesson. Harry Wong states that, "Each [objective] must begin with a verb that states the action to be taken to show accomplishment. The most important word to use in an assignment is a verb, because verbs state how to demonstrate if accomplishment has taken place or not." The objective drives the whole lesson, it is the reason the lesson exists. Care is taken when creating the objective for each day's lesson, as it will determine the activities the students engage in. The teacher also ensures that lesson plan goals are compatible with the developmental level of the students. The teacher ensures as well that their student achievement expectations are reasonable.

Assignments

Assignments are either in-class or take-home tasks to be completed for the next class period. These tasks are important because they help ensure that the instruction provides the students with a goal and the power to get there as well as the interest to be engaged in rigorous academic contexts, as they acquire content and skills necessary to be able to participate in academic coursework.

Experts cite that, in order to be effective and achieve objectives, the development of these assignment tasks must take into consideration the perception of the students because they are different from that of the teacher's. This challenge can be addressed by providing examples instead of abstract concepts or instructions. Another strategy involves the development of tasks that are more related to the learners' needs, interests, and age ranges. There are also experts who cite the importance of teaching learners about assignment planning. This is said to facilitate the students' engagement and interest in their assignment. Some strategies include brainstorming about the assignment process and the creation of a learning environment wherein students feel engaged and willing to reflect on their prior learning and to discuss specific or new topics.

There are several assignment types so the instructor must decide whether class assignments are whole-class, small groups, workshops, independent work, peer learning, or contractual:

- Whole-class—the teacher lectures to the class as a whole and has the class collectively participate in classroom discussions.
- Small groups—students work on assignments in groups of three or four.
- Workshops—students perform various tasks simultaneously. Workshop activities must be tailored to the lesson plan.
- Independent work—students complete assignments individually.
- Peer learning—students work together, face to face, so they can learn from one another.
- Contractual work—teacher and student establish an agreement that the student must perform a certain amount of work by a deadline

These assignment categories (e.g. peer learning, independent, small groups) can also be used to guide the instructor's choice of assessment measures that can provide information about student and class comprehension of the material. As discussed by Biggs (1999), there are additional questions an instructor can consider when choosing which type of assignment would provide the most benefit to students. These include:

- What level of learning do the students need to attain before choosing assignments with varying difficulty levels?
- What is the amount of time the instructor wants the students to use to complete the assignment?
- How much time and effort does the instructor have to provide student grading and feedback?
- What is the purpose of the assignment? (e.g. to track student learning; to provide students with time to practice concepts; to practice incidental skills such as group process or independent research)
- How does the assignment fit with the rest of the lesson plan? Does the assignment test content knowledge or does it require application in a new context?
- Does the lesson plan fit a particular framework? For example, a Common Core Lesson Plan.

Brainstorming

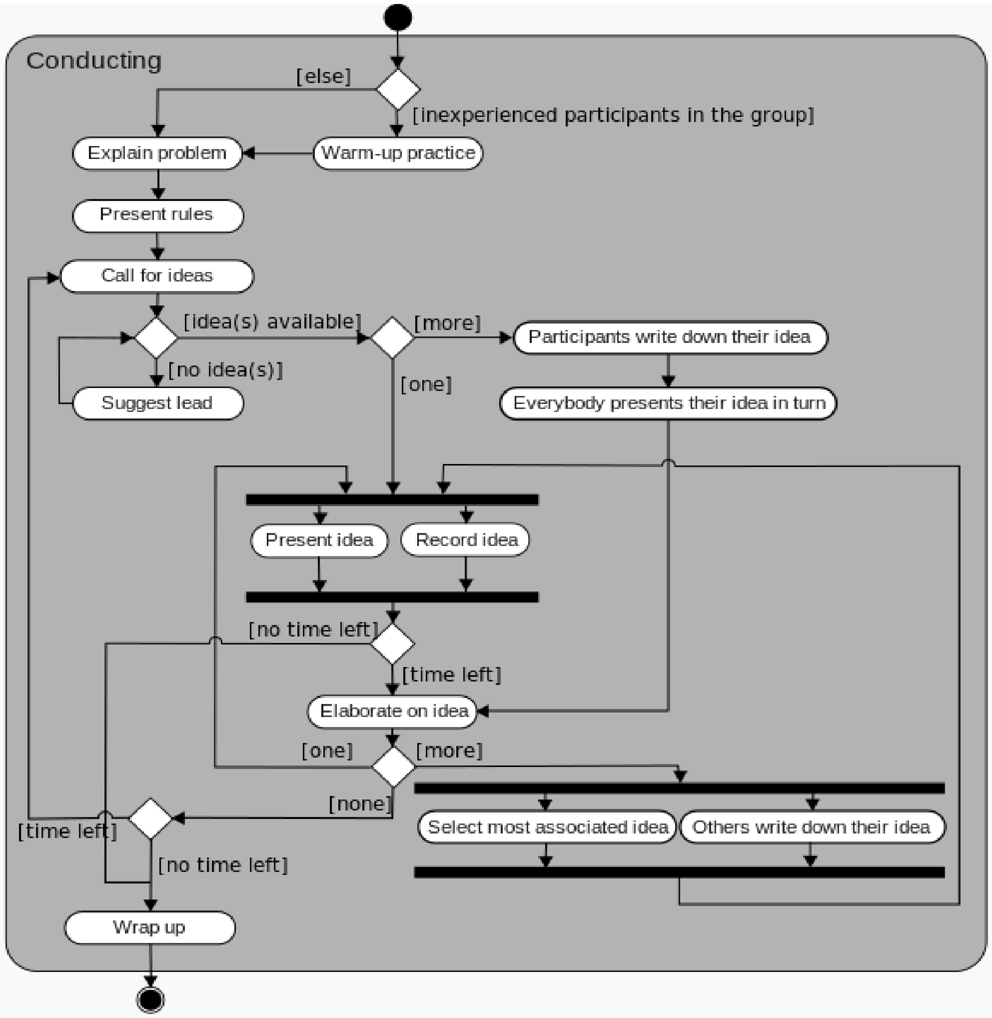
Brainstorming is a group creativity technique by which efforts are made to find a conclusion for a specific problem by gathering a list of ideas spontaneously contributed by its members.

In other words, brainstorming is a situation where a group of people meet to generate new ideas and solutions around a specific domain of interest by removing inhibitions. People are able to think more freely and they suggest many spontaneous new ideas as possible. All the ideas are noted down and are not criticized and after brainstorming session the ideas are evaluated. The term was popularized by Alex Faickney Osborn in the 1953 book *Applied Imagination*.

Origin

Advertising executive Alex F. Osborn began developing methods for creative problem-solving in 1939. He was frustrated by employees' inability to develop creative ideas individually for ad campaigns. In response, he began hosting group-thinking sessions and discovered a significant improvement in the quality and quantity of ideas produced by employees. During the period when Osborn made his concept, he started writing on creative thinking, and the first notable book where he mentioned the term brainstorming is "How to Think Up" in 1942. Osborn outlined his method in the 1948 book *Your Creative Power* in chapter 33, "How to Organize a Squad to Create Ideas".

Osborn's method



brainstorming activity conducting

Osborn claimed that two principles contribute to "ideative efficacy," these being :

1. Defer judgment,
2. Reach for quantity.

Following these two principles were his four general rules of brainstorming, established with intention to :

- reduce social inhibitions among group members.
- stimulate idea generation.
- increase overall creativity of the group.

1. **Go for quantity**: This rule is a means of enhancing divergent production, aiming to facilitate problem solving through the maxim *quantity breeds quality*. The assumption is that the greater the number of ideas generate the bigger the chance of producing a radical and effective solution.
2. **Withhold criticism**: In brainstorming, criticism of ideas generated should be put 'on hold'. Instead, participants should focus on extending or adding to ideas, reserving criticism for a later 'critical stage' of the process. By suspending judgment, participants will feel free to generate unusual ideas.
3. **Welcome wild ideas**: To get a good long list of suggestions, wild ideas are encouraged. They can be generated by looking from new perspectives and suspending assumptions. These new ways of thinking might give you better solutions.
4. **Combine and improve ideas**:As suggested by the slogan "1+1=3". It is believed to stimulate the building of ideas by a process of association.

Applications

Osborn notes that brainstorming should address a specific question; he held that sessions addressing multiple questions were inefficient.

Further, the problem must require the generation of ideas rather than judgment; he uses examples such as generating possible names for a product as proper brainstorming material, whereas analytical judgments such as whether or not to marry do not have any need for brainstorming.

Groups

Osborn envisioned groups of around 12 participants, including both experts and novices. Participants are encouraged to provide wild and unexpected answers. Ideas receive no criticism or discussion. The group simply provides ideas that might lead to a solution and apply no analytical judgment as to the feasibility. The judgments are reserved for a later date.

Variations

Participants are asked to write their ideas anonymously. Then the facilitator collects the ideas and the group votes on each idea. The vote can be as simple as a show of hands in favor of a given idea. This process is called distillation.

After distillation, the top ranked ideas may be sent back to the group or to subgroups for further brainstorming. For example, one group may work on the color required in a product. Another group may work on the size, and so forth. Each group will come back to the whole group for ranking the listed ideas. Sometimes ideas that were previously dropped may be brought forward again once the group has re-evaluated the ideas.

It is important that the facilitator be trained in this process before attempting to facilitate this technique. The group should be primed and encouraged to embrace the process. Like all team efforts it may take a few practice sessions to train the team in the method before tackling the important ideas.

Group passing technique

Each person in a circular group writes down one idea, and then passes the piece of paper to the next person, who adds some thoughts. This continues until everybody gets his or her original piece of paper back. By this time, it is likely that the group will have extensively elaborated on each idea.

The group may also create an "idea book" and post a distribution list or routing slip to the front of the book. On the first page is a description of the problem. The first person to receive the book lists his or her ideas and then routes the book to the next person on the distribution list. The second person can log new ideas or add to the ideas of the previous person. This continues until the distribution list is exhausted. A follow-up "read out" meeting is then held to discuss the ideas logged in the book. This technique takes longer, but it allows individuals time to think deeply about the problem.

Team idea mapping method

This method of brainstorming works by the method of association. It may improve collaboration and increase the quantity of ideas, and is designed so that all attendees participate and no ideas are rejected.

The process begins with a well-defined topic. Each participant brainstorms individually, then all the ideas are merged onto one large idea map. During this consolidation phase, participants may discover a common understanding of the issues as they share the meanings behind their ideas. During this sharing, new ideas may arise by the association, and they are added to the map as well. Once all the ideas are captured, the group can prioritize and/or take action.

Directed brainstorming

Directed brainstorming is a variation of electronic brainstorming (described below). It can be done manually or with computers. Directed brainstorming works when the solution space (that is, the set of criteria for evaluating a good idea) is known prior to the session. If known, those criteria can be used to constrain the ideation process intentionally.

In directed brainstorming, each participant is given one sheet of paper (or electronic form) and told the brainstorming question. They are asked to produce one response and stop, then all of the papers (or forms) are randomly swapped among the participants. The participants are asked to look at the idea they received and to create a new idea that improves on that idea based on the initial criteria. The forms are then swapped again and respondents are asked to improve upon the ideas, and the process is repeated for three or more rounds.

In the laboratory, directed brainstorming has been found to almost triple the productivity of groups over electronic brainstorming

Guided brainstorming

A guided brainstorming session is time set aside to brainstorm either individually or as a collective group about a particular subject under the constraints of perspective and time. This type of brainstorming removes all cause for conflict and constrains conversations while stimulating critical and creative thinking in an engaging, balanced environment.

Participants are asked to adopt different mindsets for pre-defined period of time while contributing their ideas to a central mind map drawn by a pre-appointed scribe. Having examined a multi-perspective point of view, participants seemingly see the simple solutions that collectively create greater growth. Action is assigned individually.

Following a guided brainstorming session participants emerge with ideas ranked for further brainstorming, research and questions remaining unanswered and a prioritized, assigned, actionable list that leaves everyone with a clear understanding of what needs to happen next and the ability to visualize the combined future focus and greater goals of the group.

Individual brainstorming

"Individual brainstorming" is the use of brainstorming in solitary situations. It typically includes such techniques as free writing, free speaking, word association, and drawing a mind map, which is a visual note taking technique in which people diagram their thoughts. Individual brainstorming is a useful method in creative writing and has been shown to be superior to traditional group brainstorming.

Question brainstorming

This process involves brainstorming the *questions*, rather than trying to come up with immediate answers and short term solutions. Theoretically, this technique should not inhibit participation as there is no need to provide solutions. The answers to the questions form the framework for constructing future action plans. Once the list of questions is set, it may be necessary to prioritize them to reach to the best solution in an orderly way.

"Questorming" is another term for this mode of inquiry.

Methods to improving brainstorming sessions

There a number of ways that groups can improve the effectiveness and quality of their brainstorming sessions

- **Avoiding face-to-face groups**: Using face-to-face groups can increase production blocking, evaluation apprehension, social matching and social loafing.
- **Stick to the rules**: Brainstorming rules should be followed, and feedback should be given to members that violate these rules. Violations of brainstorming rules tend to lead to mediocre ideas.
- **Pay attention to everyone's ideas**: People tend to pay more attention to their own ideas, however brainstorming requires exposure to the ideas of others. A method to encourage members to pay attention to others' ideas is to make them list the ideas out or ask them to repeat others' ideas.
- **Include both individual and group approaches**: One method that helps members integrate their ideas into the group is brainwriting. This is where members write their ideas on a piece of paper and then pass it along to others who add their own ideas.
- **Take breaks**: Allow silence during group discussions so that members have time to think about things through.
- **Do not rush**: Allow lots of time for members to complete the task. Although working under pressure tends to lead to more solutions initially, the quality is usually lower than if more time is spent on the task.
- **Stay persistent**: Members should stay focused and persist at the task even when productivity is low.
- **Facilitate the session**: A skilled discussion leader should lead and coordinate the brainstorming sessions. This leader can motivate members, correct mistakes, and provide a clear standard of work. They can also be used to keep track of all the ideas and make sure that these ideas are available to everyone.

Alternatives to brainstorming

If brainstorming does not work for your group, there are some alternatives that you could use instead.

- **Buzzgroups**: Larger groups can form subgroups that come up with ideas when the larger group is stumped. Afterwards, these subgroups come back together and discuss their ideas as a whole group.
- **Bug list**: Group members write down all the little problems or irritations concerning the issue they are working on, and then the group discusses solutions for each of these "bugs".
- **Stepladder technique**: A method where new members state their ideas before listening to the group's position.
- **Synectics**: A leader guides the group and discusses their goals, wishes, and frustrations using analogies, metaphors, and fantasy.

Electronic brainstorming (EBS)

Although the brainstorming can take place online through commonly available technologies such as email or interactive web sites, there have also been many efforts to develop customized computer software that can either replace or enhance one or more manual elements of the brainstorming process.

Early efforts, such as GroupSystems at University of Arizona or Software Aided Meeting Management (SAMM) system at the University of Minnesota, took advantage of then-new computer networking technology, which was installed in rooms dedicated to computer supported meetings. When using these electronic meeting systems (EMS, as they came to be called), group members simultaneously and independently entered ideas into a computer terminal. The software collected (or "pools") the ideas into a list, which could be displayed on a central projection screen (anonymized if desired). Other elements of these EMSs could support additional activities such as categorization of ideas, elimination of duplicates, assessment and discussion of prioritized or controversial ideas. Later EMSs capitalized on advances in computer networking and internet protocols to support asynchronous brainstorming sessions over extended periods of time and in multiple locations.

Introduced along with the EMS by Nunamaker and colleagues at University of Arizona was electronic brainstorming (EBS). By utilizing customized computer software for groups (*group decision support systems* or *groupware*), EBS can replace face-to-face brainstorming An example of groupware is the *GroupSystems*, a software developed by University of Arizona. After an idea discussion has been posted on *GroupSystems*, it is displayed on each group member's computer. As group members simultaneously type their comments on separate computers, those comments are anonymously pooled and made available to all group members for evaluation and further elaboration

Compared to face-to-face brainstorming, not only does EBS enhanced efficiency by eliminating travelling and turn-taking during group discussions, it also excluded several psychological constraints associated with face-to-face meetings. Identified by Gallupe and colleagues, both production blocking (reduced idea generation due to turn-taking and forgetting ideas in face-to-face brainstorming) and evaluation apprehension (a general concern experienced by individuals for how others in the presence are evaluating them) are reduced in EBS. These positive psychological effects increase with group size. A perceived advantage of EBS is that all ideas can be archived electronically in their original form, and then retrieved later for further thought and discussion. EBS also enables much larger groups to brainstorm on a topic than would normally be productive in a traditional brainstorming session.

Computer supported brainstorming may overcome some of the challenges faced by traditional brainstorming methods. For example, ideas might be "pooled" automatically, so that individuals do not need to wait to take a turn, as in verbal brainstorming. Some software programs show all ideas as they are generated (via chat room or e-mail). The display of ideas may cognitively stimulate brainstormers, as their attention is kept on the flow of ideas being generated without the potential distraction of social cues such as facial expressions and verbal language. EBS techniques have been shown to produce more ideas and help individuals focus their attention on the ideas of others better than a brainwriting technique (participants write individual written notes in silence and then subsequently communicate them with the group). The production of more ideas has been linked to the fact that paying attention to others' ideas leads to non-redundancy, as brainstormers try to avoid to replicate or repeat another participant's comment or idea. Conversely, the production gain associated with EBS was less found in situations where EBS group members focused too much on generating ideas that they ignored ideas expressed by others. The production gain associated with *GroupSystem* users' attentiveness to ideas expressed by others has been documented by Dugosh and colleagues. EBS group members who were instructed to attend to ideas generated by others outperformed those who were not in terms of creativity.

According to a meta-analysis comparing EBS to face-to-face brainstorming conducted by DeRosa and colleagues, EBS has been found to enhance both the production of non-redundant ideas and the quality of ideas produced. Despite the advantages demonstrated by EBS groups, EBS group members reported less satisfaction with the brainstorming process compared to face-to-face brainstorming group members.

Some web-based brainstorming techniques allow contributors to post their comments anonymously through the use of avatars. This technique also allows users to log on over an extended time period, typically one or two weeks, to allow participants some "soak time" before posting their ideas and feedback. This technique has been used particularly in the field of new product development, but can be applied in any number of areas requiring collection and evaluation of ideas.

Some limitations of EBS include the fact that it can flood people with too many ideas at one time that they have to attend to, and people may also compare their performance to others by analyzing how many ideas each individual produces (social matching).

Incentives

Some research indicates that incentives can augment creative processes. Participants were divided into three conditions. In Condition I, a flat fee was paid to all participants. In the Condition II, participants were awarded points for every unique idea of their own, and subjects were paid for the points that they earned. In Condition III, subjects were paid based on the impact that their idea had on the group; this was measured by counting the number of group ideas derived from the specific subject's ideas. Condition III outperformed Condition II, and Condition II outperformed Condition I at a statistically significant level for most measures. The results demonstrated that participants were willing to work far longer to achieve unique results in the expectation of compensation.

Challenges to effective group brainstorming

A good deal of research refutes Osborn's claim that group brainstorming could generate more ideas than individuals working alone. For example, in a review of 22 studies of group brainstorming, Michael Diehl and Wolfgang Stroebe found that, overwhelmingly, groups brainstorming together produce fewer ideas than individuals working separately. However, this conclusion is brought into question by a subsequent review of 50 studies by Scott G. Isaksen showed that a misunderstanding of the tool, and weak application of the methods (including lack of facilitation), and the artificiality of the problems and groups undermined most such studies, and the validity of their conclusions.

Several factors can contribute to a loss of effectiveness in group brainstorming.

Blocking:

Because only one participant may give an idea at any one time, other participants might forget the idea they were going to contribute or not share it because they see it as no longer important or relevant. Further, if we view brainstorming as a cognitive process in which "a participant generates ideas (generation process) and stores them in short-term memory (memorization process) and then eventually extracts some of them from its short-term memory to express them (output process)", then blocking is an even more critical challenge because it may also inhibit a person's train of thought in generating their own ideas and remembering them

Collaborative fixation: Exchanging ideas in a group may reduce the number of domains that a group explores for additional ideas. Members may also conform their ideas to those of other members, decreasing the novelty or variety of ideas, even though the overall number of ideas might not decrease

Evaluation apprehension: Evaluation apprehension was determined to occur only in instances of personal evaluation. If the assumption of collective assessment were in place, real-time judgment of ideas, ostensibly an induction of evaluation apprehension, failed to induce significant variance

Free-writing: Individuals may feel that their ideas are less valuable when combined with the ideas of the group at large. Indeed, Diehl and Stroebe demonstrated that even when individuals worked alone, they produced fewer ideas if told that their output would be judged in a group with others than if told that their output would be judged individually. However, experimentation revealed free-writing as only a marginal contributor to productivity loss, and type of session (i.e., real vs. nominal group) contributed much more

Personality characteristics: Extroverts have been shown to outperform introverts in computer mediated groups. Extroverts also generated more unique and diverse ideas than introverts when additional methods were used to stimulate idea generation, such as completing a small related task before brainstorming, or being given a list of the classic rules of brainstorming

Social matching: One phenomenon of group brainstorming is that participants will tend to alter their rate of productivity to match others in the group. This can lead to participants generating fewer ideas in a group setting than they would individually because they will decrease their own contributions if they perceive themselves to be more productive than the group average. On the other hand, the same phenomenon can also increase an individual's rate of production to meet the group average.

Seminar

A form of academic instruction, either at an academic institution or offered by a commercial or professional organization.] It has the function of bringing together small groups for recurring meetings, focusing each time on some particular subject, in which everyone present is requested to participate. This is often accomplished through an ongoing Socratic dialogue with a seminar leader or instructor, or through a more formal presentation of research. It is essentially a place where assigned readings are discussed, questions can be raised and debates can be conducted.

Symposium

A part of a banquet that took place after the meal, when drinking for pleasure was accompanied by music, dancing, recitals, or conversation. Literary works that describe or take place at a symposium include two Socratic dialogues, Plato's *Symposium* and Xenophon's *Symposium*, as well as a number of Greek poems such as the elegies of Theognis of Megara. Symposia are depicted in Greek and Etruscan art that shows similar scenes.

In modern usage, it has come to mean an academic conference or meeting such as a scientific conference. The equivalent of a Greek symposium in Roman society is the Latin *convivium*.

Broadly stated, the purpose of this symposium is to facilitate the free exchange of scientific information about the upper atmosphere. This conforms to one of the prime objectives of the American Meteorological Society—the “development and dissemination of knowledge of meteorology in all its phases and applications.”

Discussion group

A *discussion group* is a group of individuals with similar interest who gather either formally or informally to bring up ideas, solve problems or give comments. The major approaches are *in person*, via *conference call* or *website*. People respond comments and post forum in established mailing list, news group or IRC. Other group members could choose to respond by posting text or image.

Brief history

Discussion group was evolved from USENET which is traced back to early 80's. Two computer scientists Jim Ellis and Tom Truscott founded the idea of setting a system of rules to produce "articles", and then send back to their parallel news group. Fundamentally, the form of discussion group was generated on the concept of USENET, which emphasised ways of communication via email and web forums. Gradually, USENET had developed to be a system of channels which provide notifications and "articles" to meet general public's needs. Nowadays, World Wide Web gradually takes on the major role of supporting and extending platforms for discussion group on the Internet by setting up various web servers.

Overview of online discussion group

Google group

Google Group has been built to be one of the major online discussion groups with a wide range of worldwide frequent users. The following subsections contain information about three popular groups used by the public today:

- Simply search any theme based on personal interest by using the search box on the Google groups homepage, the results would appear after searching. Users could select themes more concisely by refining "date range, language, group or author". Users could join any groups they are interested in or establish their own.
- Three ascending levels are available for "public, announcements-only and restricted". For considering member's accessibility to information, General public commands more flexibility compares to limited users with regulations. In addition, it is a privilege to subscribe a gmail account which enables users to upload documents, send invites, and create webpage.

Facebook group

Facebook group simplifies processes and protects privacy of users when they interact with people. The following guidelines are some general instructions about how to operate groups on Facebook:

- By following instructions on homepage, users could create ideal groups that satisfy their personal needs. After the group is established, the admins are able to make a range of adjustments to the groups pages by upload display pictures and posting note and comments on the group wall. He or she could assist the whole group with events, news updates and members management. Therefore, Facebook groups, generally, diversifies internal communication by sending invitations to friends, colleagues or certain people who share similar demographics. A single user is capable of joining up a maximum "6000 groups".

Whatsapp group

Whatsapp group: Whatsapp, is a mobile SMS and messaging app, it features the function of group discussion as well. Users set group chats to boost the convenience of a proper group discussion. With shared characteristics to Facebook group, the instructions are comparatively similar. Common actions for administrators include: creating group, renaming title, blocking members, deleting irrelevant information through the management.

Advantage

- Advantages: the implementation of Google Groups comes with its own advantages. For diverse users, it provides the service of interpreting languages widely, which helps present a better way to communicate effectively with people in different countries. Considering of storage, one group member enjoys "100 megabytes (MB)" while there are no restrictions for the whole group. It delivers convenience for group members work on projects that need considerably more storage than normal files, for example, presentations. Studies conducted by Kushin and Kitchener indicates Facebook provide users in discussion groups with more opportunities to post content that has correlation with "social, political, or sporting issues". For Whatsapp users, the communication service brings enjoyment to share ideas with comparatively low cost. Ideally, it enhanced the quality of communication regarding of its records saving, security and trustability.
- Information in Discussion groups are usually archived. For example, Google's *Groups* (formerly DejaNews) is an archive of Usenet articles trace back to 1981. Discussion group archives are sometimes an effective way to find an answer to very ambiguous questions.

Academic

- Small group of professionals or students formally or informally negotiate about an academic topic within certain fields. This implementation could be seen as an investigation or research based on various academic levels. For instance, "one hundred eighty college-level psychology students" breakdown into different groups to participate in giving an orderly arrangement of preferred events.[15] Nevertheless, discussion groups could support professional services and hold events to a range of demographics; another distinguished example is from "The London Biological Mass Spectrometry Discussion Group", which sustainably operates by gathering "technicians, clinicians, academics, industrialists and students" to exchange ideas on an academic level. It attributes to the development of participants' cognitive, critical thinking, and analytical skills.

Workshop

This museum workshop containing tools and supplies has been in use for decades.

A railway workshop.

Beginning with the Industrial Revolution era, a **workshop** may be a room, rooms or building which provides both the area and tools (or machinery) that may be required for the manufacture or repair of manufactured goods. Workshops were the only places of productionuntil the advent of industrialization and the development of larger factories. In the 20th and 21st century, many Western homes contain a workshop in the garage, basement, or an external shed. Home workshops typically contain a workbench, hand tools, power tools and other hardware. Along with their practical applications for repair goods or do small manufacturing runs, workshops are used to tinker and make prototypes.

Workshops may vary in industrial focus. For instance, some workshops may focus on automotive repair or restoration. Woodworking is one of the most common focuses, but metalworking, electronics work, and many types of electronic prototyping may be done.

What’s the Difference Between a Seminar, Workshop and Conference? What You Name Your Event Can Communicate Volumes About the Experience

Seminars, workshops, conference, symposia, user conferences, summits -- the type of events you can host are varied. Choosing the right description for your event is critical because it communicates volumes about the type of experience your participants can expect.

To ensure that you’re fully leveraging the marketing power of your event title, select the type of event that best fits the experience you want to create. Here’s a quick explanation of each type of event.

Seminars are educational events that feature one or more subject matter experts delivering information primarily via lecture and discussion.

Free Seminars are an increasingly popular way to generate qualified leads for your business. Many professionals and organizations recognize that the best way to convince prospects of their expertise is to deliver high-quality education and, therefore, deliver free seminars that are high in content. Others, however, use the promise of free education to lure information-seeking prospects to a sales pitch. As a result, many prospective customers are wary about attending a free seminar for fear of being subjected to a high-pressure sales pitch.

Introductory or Preview Seminar implies that there is more to come after this particular event. This can be a good way to name free events that are designed to give prospective attendees a taste of what they can expect in a larger, more expensive program.

Workshops tend to be smaller and more intense than seminars. This format often involves students practicing their new skills during the event under the watchful eye of the instructor.

Hands-On Workshops typically involve participants doing work on a particular issue during the program. The promise is that when they leave, they’ll have at least a rough plan or tools in place to address the challenge.

Conferences often features keynote presentations delivered to all attendees, as well as multiple break-out sessions. Attendees often expect to receive information about industry trends and developments.

User Conferences are gatherings hosted by providers of products and services to educate and build relationships with their customers. Attendees learn about product enhancements, as well as new and advanced strategies for using the product to achieve business goals and solve problems.

Trade Shows or Expos are exhibitions where vendors can display their goods and services in hopes of generating customer leads. Typically held at least annually, these events are a good place to discover trends and developments in a particular industry.

A Symposium is typically a more formal or academic gathering, featuring multiple experts delivering short presentations on a particular topic.

A Summit is a gathering of the highest level of leaders and experts.
Teleseminars are seminars that are delivered via a conference call over the telephone and/or over the Internet. The instructor moderates the call, while the attendees listen. To engage listeners, many instructors provide outlines, notes sheets or copies of PowerPoint slides to follow when listening to the presentation.

Webinars or Webconferences are presentations that involve an audio and video component. The audio portion of the event is delivered via phone or over the Internet, so that participants can listen via their computer speakers. The video portion of the event is delivered via the Internet, giving participants a presentation to watch while listening to the instructor.

When determining how to label your event, consider the type of presentation you want to deliver. Also consider what your competitors are doing. If your niche is already crowded with seminars, position your event as different by increasing the level of instructor-attendee interaction and making it a workshop … or by involving other experts and offering multiple breakout sessions to transform it into a conference.

By carefully choosing the words you use to describe your event, you'll be able to subtly communicate the benefits of participating and attract the right kind of attendee for your event.

Programmed learning

Programmed learning (or programmed instruction) is a research-based system which helps learners work successfully. The method is guided by research done by a variety of applied psychologists and educators.

The learning material is in a kind of textbook or teaching machine or computer. The medium presents the material in a logical and tested sequence. The text is in small steps or larger chunks. After each step, learners are given a question to test their comprehension. Then immediately the correct answer is shown. This means the learner at all stages makes responses, and is given immediate knowledge of results

Anticipating programmed learning, Edward L. Thorndike wrote in 1912:

> “ If, by a miracle of mechanical ingenuity, a book could be so arranged that only to him who had done what was directed on page one would page two become visible, and so on, much that now requires personal instruction could be managed by print. ”

— *Edward L. Thorndike, Education: A First Book*[1]

Thorndike, however, did nothing with his idea. The first such system was devised by Sidney L. Pressey in 1926. "The first... [teaching machine] was developed by Sidney L. Pressey... While originally developed as a self-scoring machine... [it] demonstrated its ability to actually teach."

Later developments

In World War II, with largely conscript armies, there was great emphasis on training. What was learnt influenced education and training after the war. One of the main methods was the use of film as a group training method. Research on the effectiveness of training films was done extensively. In one account, Lumsdaine comments that research on films went on "from about 1918 to the present" (meaning 1962).

A few conclusions stood out from the research. First, films were great at giving overviews of a situation or an operation. However, they were less successful at getting over the details. Some general features of film (and, later, television) stand out. One is that a film goes at its own pace. Another is that no specific responses or activities are required from the viewer. A third is that the audience is varied, sometimes hugely varied. This gives clues to ways of improving instructional films.

In a 1946 experiment at Yale University, questions for students were put between segments of a film on the heart and circulation, with correct answers given after students had responded (knowledge of results). This added significantly to the amount learnt from the film. Lumsdaine commented that showing the version with questions and answers was as effective as showing the film twice, and faster.

The connections between this experiment and those of Pressey were obvious. Active responses by learners and helpful feedback on the activities were now seen as critical elements in any successful system of learning. Pressey's work had been half forgotten, but it was now recognised as significant.

Programmed learning arrives

What is programmed learning?]

If so much research had already been done on learning from films, what exactly did programmed learning add? The short answer is "stimulus control", by which is broadly meant the teaching material itself. Also, in programmed learning, a complete system was proposed which included these stages:

1. The aims of the course are stated in terms which are objective, and can be measured.
2. A pre-test is given, or the initial behaviour is stated.
3. A post-test is provided.
4. The materials have been tried out and revised according to results (developmental testing).
5. The materials are constructed according to a predetermined scheme (stimulus control).
6. The material is arranged in appropriate steps.
7. The learner has to respond actively (not necessarily overtly).
8. Arrangements are made for responses to be confirmed (knowledge of results).
9. The teaching medium is appropriate for the subject-matter and the students.
10. The materials are self-paced or presented in a manner which suits the learner.

A helpful discussion of the different programming techniques was given by Klaus.

The two main systems of programmed learning

Although there were three or four other systems proposed, we discuss here the two best-known methods.

One was by Norman Crowder, a psychologist with the U.S. Air Force. He had been asked to investigate the training of aircraft maintenance men. Crowder's system was to set multiple choice questions in the text, and provide feedback for each of the alternatives.[20][21][22] Examples of this method show that the alternatives offered in questions were chosen to cover mistakes which students were likely to make.[3][19] Crowder's system, which he called "intrinsic programming", was better known as "branching programming" on account of its multiple-choice alternatives.

Much better known was the other style of programmed learning, as proposed by the behaviourist B.F. Skinner. Skinner made some very effective criticisms of traditional teaching methods. His scheme of programmed instruction was to present the material as part of a "schedule of reinforcement" in typical behaviourist manner. The programmed text of Skinner's theory of behaviorism is the most complete example of his ideas in action. Skinner's system was generally called "linear programming" because its activities were placed in otherwise continuous text. Skinner was a wonderful publicist for his own ideas, as can be seen from this passage:

> "There is a simple job to be done. The task can be stated in concrete terms. The necessary techniques are known. The equipment can easily be provided. Nothing stands in the way except cultural inertia... We are on the threshold of an exciting and revolutionary period in which the scientific study of man will be put to work in man's best interests. Education must play its part. It must accept the fact that sweeping revision of educational practice is possible and inevitable...".

Both methods were originally presented in machines, and both were later presented in book form. Both systems were to an extent student centered. They were ways of teaching individual learners who worked at their own pace. Both systems (in different ways) used knowledge of results to promote learning. In both systems the content was pre-tested to identify problems and iron them out. Both systems emphasised clear learning objectives. Progress in learning was measured by pre- and post-tests of equivalent difficulty. Many practical tests showed the effectiveness of these methods

Later effects

Many of these ideas were picked up and used in other educational fields, such as open learning (see the Open University) and computer-assisted learning.

Programmed learning ideas influenced the Children's Television Workshop, which did the R&D for *Sesame Street*. The use of developmental testing was absolutely characteristic of programmed learning. The division of the individual programs into small chunks is also a feature of programmed learning

Even more is this true of *Blue's Clues*. Unlike *Sesame Street*, which tested a third of its episodes, the *Blue's Clues* research team field tested every episode three times with children aged between two and six in preschool environments such as Head Start programs, public schools, and private day care centers. There were three phases of testing: content evaluation, video evaluations, and content analysis. Their tests of the pilot, conducted throughout New York City with over 100 children aged from three to seven, showed that the attention and comprehension of young viewers increased with each repeat viewing.

Learning or training?

The terms "programmed learning" and "programmed training" were interchangeable, because the principles and methods were almost identical If the target audience was industrial or military, researchers used the term programmed training, because training budgets supported the work. But in schools and colleges, the work was often described as programmed learning.

Many accounts used either or both terms according to which interest was paying for the work. Sometimes researchers used both terms as explicit alternatives. Some surveys standardised on using just one of the terms

Perhaps the only distinction was the way the "terminal behaviours" (the final test demonstrating what the learner had learnt) were arrived at. In training, the goals were decided by a process called task analysis, or critical incident technique. This was based on the key activities which a trained person should be able to do. In educational work, deciding on the terminal test was not so securely grounded. One school of thought, probably the majority, decided to turn the rather vague statements of educational aims into full-fledged behavioural statements of the kind "At the end of this program, students should be able to do the following...". A pamphlet by Robert Mager was influential because it showed how to do this. This worked well with some subject matters, but had its limitations. In general, educators have reservations as to how far a list of behaviours captures what they are trying to teach. Subjects differ greatly in their basic aims, but where programmed learning suited a topic, most field trials gave positive results.

Examples

Daily Oral Language and the *Saxon method*, a math programme, are specific implementations of programmed instruction which have an emphasis on repetition.

Well-known books using programmed learning include the Lisp/Scheme text *The Little Schemer*, *Bobby Fischer Teaches*

Chess, and *Laplace Transform Solution Of Differential Equations: A Programmed Text*, by Robert D. Strum and John R. Ward of the Naval Postgraduate School. Several available foreign language reading textbooks also use programmed learning.

Recently, the application of programmed instruction principles was applied to training in computer programs

Team Teaching

Team teaching involves a group of instructors working purposefully, regularly, and cooperatively to help a group of students of any age learn. Teachers together set goals for a course, design a syllabus, prepare individual lesson plans, teach students, and evaluate the results. They share insights, argue with one another, and perhaps even challenge students to decide which approach is better.

Teams can be single-discipline, interdisciplinary, or school-within-a-school teams that meet with a common set of students over an extended period of time. New teachers may be paired with veteran teachers. Innovations are encouraged, and modifications in class size, location, and time are permitted. Different personalities, voices, values, and approaches spark interest, keep attention, and prevent boredom.

The team-teaching approach allows for more interaction between teachers and students. Faculty evaluate students on their achievement of the learning goals; students evaluate faculty members on their teaching proficiency. Emphasis is on student and faculty growth, balancing initiative and shared responsibility, specialization and broadening horizons, the clear and interesting presentation of content and student development, democratic participation and common expectations, and cognitive, affective, and behavioral outcomes. This combination of analysis, synthesis, critical thinking, and practical applications can be done on all levels of education, from kindergarten through graduate school.

Working as a team, teachers model respect for differences, interdependence, and conflict-resolution skills. Team members together set the course goals and content, select common materials such as texts and films, and develop tests and final examinations for all students. They set the sequence of topics and supplemental materials. They also give their own interpretations of the materials and use their own teaching styles. The greater the agreement on common objectives and interests, the more likely that teaching will be interdependent and coordinated.

Teaching periods can be scheduled side by side or consecutively. For example, teachers of two similar classes may team up during the same or adjacent periods so that each teacher may focus on that phase of the course that he or she can best handle. Students can sometimes meet all together, sometimes in small groups supervised by individual teachers or teaching assistants, or they can work singly or together on projects in the library, laboratory, or fieldwork. Teachers can be at different sites, linked by video-conferencing, satellites, or the Internet.

Breaking out of the taken-for-granted single-subject, single-course, single-teacher pattern encourages other innovations and experiments. For example, students can be split along or across lines of sex, age, culture, or other interests, then recombined to stimulate reflection. Remedial programs and honors sections provide other attractive opportunities to make available appropriate and effective curricula for students with special needs or interests. They can address different study skills and learning techniques. Team teaching can also offset the danger of imposing ideas, values, and mindsets on minorities or less powerful ethnic groups. Teachers of different backgrounds can culturally enrich one another and students.

Advantages

Students do not all learn at the same rate. Periods of equal length are not appropriate for all learning situations. Educators are no longer dealing primarily with top-down transmission of the tried and true by the mature and experienced teacher to the young, immature, and inexperienced pupil in the single-subject classroom. Schools are moving toward the inclusion of another whole dimension of learning: the lateral transmission to every sentient member of society of what has just been discovered, invented, created, manufactured, or marketed. For this, team members with different areas of expertise are invaluable.

Of course, team teaching is not the only answer to all problems plaguing teachers, students, and administrators. It requires planning, skilled management, willingness to risk change and even failure, humility, open-mindedness, imagination, and creativity. But the results are worth it.

Teamwork improves the quality of teaching as various experts approach the same topic from different angles: theory and practice, past and present, different genders or ethnic backgrounds. Teacher strengths are combined and weaknesses are remedied. Poor teachers can be observed, critiqued, and improved by the other team members in a nonthreatening, supportive context. The evaluation done by a team of teachers will be more insightful and balanced than the introspection and self-evaluation of an individual teacher.

Working in teams spreads responsibility, encourages creativity, deepens friendships, and builds community among teachers. Teachers complement one another. They share insights, propose new approaches, and challenge assumptions. They learn new perspectives and insights, techniques and values from watching one another. Students enter into conversations between them as they debate, disagree with premises or conclusions, raise new questions, and point out consequences. Contrasting viewpoints encourage more active class participation and independent thinking from students, especially if there is team balance for gender, race, culture, and age. Team teaching is particularly effective with older and underprepared students when it moves beyond communicating facts to tap into their life experience.

The team cuts teaching burdens and boosts morale. The presence of another teacher reduces student-teacher personality problems. In an emergency one team member can attend to the problem while the class goes on. Sharing in decision-making bolsters self-confidence. As teachers see the quality of teaching and learning improve, their self-esteem and happiness grow. This aids in recruiting and keeping faculty.

Disadvantages

Team teaching is not always successful. Some teachers are rigid personality types or may be wedded to a single method. Some simply dislike the other teachers on the team. Some do not want to risk humiliation and discouragement at possible failures. Some fear they will be expected to do more work for the same salary. Others are unwilling to share the spotlight or their pet ideas or to lose total control.

Team teaching makes more demands on time and energy. Members must arrange mutually agreeable times for planning and evaluation. Discussions can be draining and group decisions take longer. Rethinking the courses to accommodate the team-teaching method is often inconvenient.

Opposition may also come from students, parents, and administrators who may resist change of any sort. Some students flourish in a highly structured environment that favors repetition. Some are confused by conflicting opinions. Too much variety may hinder habit formation.

Salaries may have to reflect the additional responsibilities undertaken by team members. Team leaders may need some form of bonus. Such costs could be met by enlarging some class sizes. Nonprofessional staff members could take over some responsibilities.

All things being considered, team teaching so enhances the quality of learning that it is sure to spread widely in the future.

Need and Importance of In-service computer science teacher

Computers play a vital role in every field. They aid industrial processes, they find application in medicine; they are the reason why software industries developed and flourished and they play an important role in education

But they are teaching students in schools about computers more theoretically than practical education. ... The goal of technological education is to make students better thinkers, creative and confident. That helps them in higher education and in life. Education play very important role in our life and career development.

Unit IV: Instructional Aids and Methods Instructional Aids

Teaching aids

An integral component in any classroom. The many benefits of teaching aids include helping learners improve reading comprehension skills, illustrating or reinforcing a skill or concept, differentiating instruction and relieving anxiety or boredom by presenting information in a new and exciting way.

Characteristics of good teaching aids

1) **Teaching aids** are large enough to be seen by the students for whom they are used.
2) **Teaching aids** are meaningful and they always stand to serve a useful purpose.
3) **Teaching aids** are up to the mark and up to date in every respect.

Classification of Teaching aids

It plays a key role in teaching-learning situations. It works as the support to both teacher and taught in the pursuit of knowledge and curriculum transaction. Teaching aids are the tools purposefully designed to overcome verbal deficiencies in communication in a classroom situation. Teaching aids are divided into different types as per their nature of function and usability.

Classification

1. Auditory Aids: - These aids produce sound and act through the ear. These are:

(i) Gramophone

(ii) Tape Recorder

(iii) Radio.

2. Visual Aids: - These aids present pictures and matters act through the eyes. These are: -

(i) The chalk-board

(ii) The flannel-board

(iii) The bulletin-board

(iv) Projected aids, such as slides, epidiascope film-strips and motion pictures etc.

(v) Representations—charts, sketches, flash cards, posters, cartoons, pictures etc.

3. Audio-Visual aids: - These aids produce both pictorial and sounds which influence mind both through the eyes and ears. These are: -

(i) Television

(ii) Sound motion pictures

4. Activity aids: - These aids induce direct participation of students and teachers to get firsthand knowledge. These are: -

(i) Tours, Excursion, field trips.

(ii) Collection of specimens, models, pictures, coins etc.

(iii) Preparation of models, charts, puppets etc.

(iv) Dramatics, Demonstration.

WHAT ARE NON-PROJECTED VISUALS

Non projected visuals are those aids which are used without any projection. So they translate abstract ideas into a more realistic format. They allow instruction to move from verbal representation to a more concrete level.

ADVANTAGES OF NON PROJECTED VISUALS

1. Abundant and are easily obtainable.
2. Requires no electricity
3. Appropriate for low budget
4. Not much artistic ability is required in the use of these visual aids.
5. Can be used in many ways at all levels of instruction and discipline
6. Used to stimulate creative expression such as tell stories or writing stores
7. Many of them can be converted into projected aids.
8. Some of them can be projected through an opaque projector.

Types of Non-Projected Visuals

Still pictures
Drawings
Charts
Graphs
Cartoon
Real objects
Models
Dioramas
Field trip
Display surfaces
Other free and inexpensive materials (Newspapers, flash cards, etc

Definition of terms: Projected visual aids are pictures shown upon a screen by use of a certain type of machine such as a filmstrip projector, slide projector, overhead projector or TV/VCR.

Values of projected visuals.

A. Provides greater enjoyment in learning
B. Stimulates more rapid learning
C. Increases retention: larger percentages and longer retention
D. Makes teaching situation adaptable to wider range
E. Compels attention
F. Enlarges or reduces actual size of objects
G. Brings distant past and the present into the classroom
H. Provides an easily reproduced record of an event
I. Influences and changes attitudes

Types of projections used most frequently in church work:

A. Video
B. Filmstrips
C. Overheads

Utilization of Materials:

A. Preview every visual for age appropriation, issues and doctrine.
B. Use the visual resource as a <u>support</u> to the Bible study, not a <u>replacement</u>.
1. Visual resources are a tool intended to <u>help</u> build a complete picture.
2. They are not to be a time filler for the unprepared lesson.

Guide to Selecting Instructional Materials

INTRODUCTION TO THE GUIDE

The instructional materials used in K-12 science classes provide the basis for what students can learn and what teachers should teach. The process used to select those materials is critical to providing students and teachers with a solid foundation for achievement and successful teaching. This guide is designed to help school personnel review and select science instructional materials. Specifically, this guide will be most useful to anyone appointed to facilitate the process — for example, a district or state science program administrator, a science department head, or a school principal. The facilitator will work with both the review and selection teams and eventually will seek approval from a school board, advisory board, or principal.

In some cases, individual schools or teachers may work alone to review and select materials; in other cases, communities and states may review and recommend materials for adoption lists. Since the applicable policies and logistical arrangements are highly variable, this guide cannot address all situations. Rather, the guide is based on principles and processes that individuals, committees, and communities may adapt for their unique circumstances and needs.

The review process is designed to be more open-ended than most and to rely heavily on the professional judgments of the reviewers rather than scales, formulas, and averages. As such, it is similar to the type of review used by scientists to evaluate each other's scientific work. This may be perceived to be a drawback because this type of review will be new to most reviewers of instructional materials. In addition, in order to produce a reliable review, reviewers will need to be versed in the standards, to have experience teaching the grade levels for which materials are being considered, and to have the knowledge and understanding of science as described in national standards. In the end, the experience of carrying out the kind of rigorous review that is common in the scientific world, requiring so much background, will be valuable on many levels. It will provide a significant professional growth experience for many reviewers, help develop a local capacity to select and implement a strong science program successfully, and contribute to developing leadership among local science educators.

Assumptions

This guide and the process it advocates are based on four key assumptions:

1. The selection of instructional materials can be carried out either for a comprehensive science program or for a small part of such a program. The process in this guide can be used equally well for a variety of selection needs: selecting materials for a multiyear program (for example, K-5, 6-8, or 9-12); meeting a specific goal (such as identifying instructional materials for a new ninth grade physics course); or selecting a single unit of study for part of a year.
2. The review of instructional materials, which precedes selection, will be based on standards; that is, specific student learning goals. Applying standards to the process makes student learning of important concepts and skills a key factor in making selection decisions. It is also assumed that local policies will determine the source of the standards to be used — national, state, or local.
3. A curriculum framework (see box) is in place that is based on standards and describes a scope and sequence for student learning. It also is assumed that the selection process involves decisions about which instructional materials are most likely to help students achieve the learning goals given in the framework.
4. At least two people will review each instructional material, and a group including both experienced teachers and scientists will collaborate in the review process. Experienced teachers contribute their knowledge of how children learn, how to manage a classroom learning environment, and the particular challenges of the local student population. Scientists can contribute their broad knowledge of science content and scientific inquiry and can be particularly helpful in reviewing the importance of the content and its accuracy.

"Curriculum framework," as used here, means the design for a science program. Frameworks can be official documents representing a mandate approved at the state, county, or district level or can be working documents, useful for sketching out proposed components of a multigrade science program. Many frameworks are published as a matrix of topics and grades or grade ranges. A review and selection process can identify resources for each cell in the matrix.

Review and Selection Process Overview

The review and selection process in this guide differs from some other processes in that it has been designed to rely on the individual and collective judgments of the reviewers, not on checklists, scales, or rubrics. The judgments are based on standards, and incorporate evidence about how likely it is that students will learn through use of the materials. The final products include a review team summary report and recommendations to the decision-making body. Provision is made for consideration of the costs of the materials and reviewer opinions about the need for teacher professional development. These processes are designed to be flexible to suit various purposes, timelines, and available resources.

The review process generates information about the quality of instruction units — the building blocks of a complete science curriculum. The selection of a collection of materials should not be viewed as the equivalent of constructing a multiyear curriculum program. For more information about constructing a complete science program, see *Designs for Science Literacy* (AAAS, forthcoming a) and *Designing Mathematics or Science Curriculum Programs: A Guide for Using Mathematics and Science Education Standards* (NRC, 1999a).

The review and selection process presented here is written as a guide for the person responsible for organizing and carrying out the task, the facilitator. The complete process is made up of five steps:

1. A Facilitator Plans the Review.
2. Training Reviewers.
3. Carrying Out the Review of Materials.
4. Selecting Materials.
5. Evaluating the Process and Results.

There are consequences for omitting any of the parts, some of which are discussed in sections entitled "Constraints and Cautions." If, over time, the entire process is implemented, and increasing numbers of teachers and community members have an opportunity to participate, the local capacity to select effective instructional materials will be greatly enhanced.

STEP 1: A FACILITATOR PLANS THE REVIEW

As the facilitator, you should begin planning at least a year before final instructional material selections are scheduled to be made. During this planning time, you will be gathering data about the effectiveness of existing science education programs, becoming familiar or reacquainted with state and local policies concerning instructional materials selection, and constructing an action plan and budget. In the process, you will be contacting school personnel and community members for information and opinions, as well as building awareness of the existing program and the possible need for changes.

Recommended Process

Policy information. Compliance with policy is necessary to gain final administrative approval and access to funds for new instructional materials. For example, you will need to know whether your state produces lists of materials from which you must select materials and when state and local funds will become available. Information about deadlines can be especially important in budget planning and for avoiding unnecessary delays. Find out how flexible the policies and regulations are and the consequences of not conforming to policy. Take advantage of the Internet, conferences, and publications to stay current.

If your local plans and needs conflict with state policies or regulations, you have time to build administrative and community support for solutions. Find out about policy waivers and the recent history of how many have been granted. Talk to local administrators about the options available and your concerns in order to gauge their support. Make sure you know the history of local selection practices.

Budget planning. Each review situation will have unique policies and resources for completing the review. At a minimum, develop a budget for two days of training prior to the actual review — one to understand the process and define the criteria and one to do a mock review. In order to make a rough estimate of the time that will be required to do the review, use the following guideline taken from field-test experience: three hours per reviewer (use a minimum of two reviewers) to carry out a review using three standards on one piece of instructional material that is designed to support about eight weeks of the school curriculum.

These minimal time recommendations assume that:

- some community scientists are already informed of and involved in
- science curriculum planning, implementation, and evaluation, and therefore are comfortable working with school personnel;
- your potential reviewers have a reasonably deep understanding of standards; and

- professional development for science teachers and ongoing community outreach has developed a broad common understanding of effective science education programs and practices.

If the preceding capabilities are not available, you will need more resources for as many capacity-building activities as possible.

Be sure that you have provided funds for the staff required for the extensive preparation and facilitation of the review and selection processes. Also plan for the time and associated costs required for community outreach activities. Obtaining and organizing the materials to be reviewed can be very time consuming. Your budget should adequately allow for this task and any shipping or storage fees that may be necessary.

Coordination with other science education initiatives. Contact those persons responsible for curriculum and instruction inside and outside your immediate program. Use their advice to compile a broad account of local science education efforts, including a history of recent professional development in science, sources of current funding, and projects and programs in science teaching and learning that are under way or planned. Research new science education initiatives being discussed or to be launched soon in the region or state. Coordination with the plans and proposals of others involved in science education in your area may enable you to share resources for recruiting and training reviewers, developing community support for the science program, and planning for the successful implementation of the new program. Become familiar with the processes used and lessons learned by colleagues in other disciplines who have recently completed instructional materials selection. Make a written summary of these findings. These will be useful later in training reviewers and making presentations to administrators and community groups.

Data collection. Compile and analyze evidence on current student achievement in science, teacher opinions on what is working, elements of the science program in need of revision, and community perceptions of the science program. An anonymous survey of the materials that teachers are actually using may be necessary, since the curriculum prescribed by current policies may not be the one that has been implemented in the classroom. A survey of parents and students will not only collect useful data, but also increase interest in the review, selection, and approval processes.

In addition to the basic reporting of standardized test scores, a study of the item analyses can provide useful data on student achievement. This information is usually provided along with the overall scores to school administrators. Professional development in how to interpret and apply the test-item analysis information is useful for principals and teachers, who are then better prepared to provide information on student achievement. In regions that disaggregate the test scores in a number of ways — by gender, race, courses, or classrooms — it is possible to further pinpoint needs that should be taken into consideration in selecting instructional materials.

Another source of data related to student science achievement is enrollment data in upper-level science courses, in which students enroll by choice or by meeting prerequisites. Improvements in the science courses should show a trend to increased demand and enrollment for advanced courses, as well as an increased participation of currently underrepresented minorities.

The information collected before the review will help influence final selection decisions and provide compelling background information in support of your recommendations during the approval process.

Identification and involvement of community stakeholders. Support from influential members of the community will be critical when recommendations for the ultimate selections need to be approved and when the new materials are introduced into schools. Selected local scientists and engineers from industry, faculty of local colleges and universities from both the education and science departments, and leaders of science education programs can be made members of an advisory board, along with teachers, students, and parents. Some members of this board may become reviewers and trainers. Participation in the advisory board and in the review and selection process will help educate community members about the curriculum, standards, classroom needs, and available instructional materials.

Involve the community in learning about the science program through district, school-level, and community activities such as open house events, community meetings, and newsletters. Educate participants about program goals and the science standards and gather opinions and suggestions. Keep community members informed through periodic updates using all of the news media available in your community.

Recruit reviewers. Choose highly qualified people whose judgments can be trusted to help increase student achievement in science. Selection criteria should include science content knowledge, demonstrated knowledge of effective teaching practices, and depth of knowledge of science standards. Individuals who have participated in professional development in science will have a common base of experience. Recruitment will be enhanced by including a description of the training to be provided and the professional growth benefits of participation.

Science subject matter knowledge is the most fundamental requirement for reviewers. Teachers often will have acquired this knowledge through classes and experience outside the district's professional development program. Therefore, be sure to collect background information on all potential reviewers, including their college majors, previous experience, and summer internships, through an application process.

To identify a pool of potential teacher reviewers, obtain information on participants in past professional development for science teachers. This may also be a useful exercise for identifying scientists and university faculty who could serve as reviewers. Community advisory groups and partnership activities may also yield potential reviewers, such as practicing scientists and engineers. By all means, try to identify those who have had experience working with school personnel. Consider requesting information from each potential reviewer on possible conflicts of interest and sources of bias, such as participation in professional development sponsored by publishers, past and present consultant agreements, or experience in publisher field tests. Reviewers need not necessarily be excluded because of these activities: when the team convenes, possible biases and conflicts of interest should be declared by each individual and that information then used to avoid potential problems.

Build the capacity of the reviewers. The success of your review and selection process depends on the depth of knowledge of the reviewers — of science subject matter, standards, and effective science teaching. Invest as much as possible in building this knowledge and experience. These professional growth opportunities need not be limited to the reviewers. Wider participation will not only build capacity to review new materials but, more broadly, to accept and implement them.

Resources outside your immediate locale can help you build the necessary capacity. Various organizations provide leadership development opportunities, many focused on improving science and mathematics education. For example, Project 2061 offers extensive training in the review of instructional materials, which makes for excellent facilitator preparation even when not possible for all reviewers. National or state organizations may offer professional development on the *Standards, Benchmarks,* and state standards. Universities may offer seminars on how children learn and the efficacy of various assessment strategies. Partnership programs with local science and technology organizations can provide important information on current scientific knowledge and practices.

Pilot-test materials. If there is sufficient lead time (at least six months), plan to have reviewers and others actually use materials in their classrooms. This is particularly valuable when innovative instructional strategies are represented in the materials or when the materials use new technology. Provide training and support for the use of the materials to help ensure that the pilot is a fair test of the quality of the instructional materials. Initially, pilot teachers will be strongly biased by their experiences — good or bad — with the new instructional materials. Sufficient time and frequent opportunities to discuss their experiences with others can moderate the effects of this bias on the review and selection processes.

Constraints and Cautions

If you are short on time, use the policy information and science program effectiveness data that you have on hand. Depend on existing and experienced advisory bodies and educators who are interested in science. Because short timelines are unlikely to produce much of a change from the status quo, consider seeking approval for a postponement of the deadline, if necessary.

If you are short on money, give existing advisory boards preparation tasks or at least seek their help in finding resources. If policy will allow, consider confining the scope of the instructional material review to those areas identified as most in need of improvement.

If you cannot recruit reviewers according to the criteria suggested here, plan to spend more time in training the reviewers. Sometimes members of the review and selection team are political appointees, a situation helpful in gaining eventual approval of the instructional materials recommended. Adequate training will be even more important in developing a common understanding of the task and a common background knowledge about science program goals, if the members of your team have an uneven knowledge about science education standards, effective instruction, and local policies.

If the community lacks knowledge about your science program, consider who is most likely to affect the selection process and then target your outreach efforts to them. If your community has contradictory ideas about the need for science program improvement, do not skimp on this initial step of preparation. A well-planned and well-executed review process ultimately can be annulled by lack of community support. Schedule frequent progress discussions with other administrators to obtain their advice and commitment as well.

If you arrange for publisher representatives to make presentations to reviewers, try to provide a level playing field for large and small publishers. Give all presenters a common format to follow and forbid the offering or accepting of gifts (which is usually prohibited by local policy anyway). Remember that reviewers can be inappropriately influenced by these presentations, even if they involve only an overview of the program and its components. Caution reviewers to look for evidence to support the claims made by the publishers.

To save time and money, a common impulse is to narrow the field of materials to be reviewed by some kind of prescreening. Various scenarios were examined during the development of this guide, and each carries some risk of undermining a valid review process. The most promising current resources for prescreening are those reviews of science materials published by organizations that have made a large investment in developing both detailed review criteria and the reviewer expertise. Most notably, Project 2061 is producing in-depth reviews based on its *Bench-marks for Science Literacy* (AAAS, forthcoming c). These reviews compare materials according to various criteria and are available on the Internet (See Chapter 5 "Resources for Training"). The National Science Resources Center has produced two books of recommended instructional resources, one for elementary school science, and one for middle school science (NSRC, 1996, 1998). The criteria used are provided as appendixes in both books, with the full text available on the Internet (See Chapter 5 "Resources for Training"). Another source of middle school science review information is the Ohio Systemic Initiative (Ohio Systemic Initiative, 1998).

If there is community-wide agreement on the success of some elements of the current science program (e.g., high student achievement and teacher satisfaction), it may be possible to keep those elements in place and focus the review on revising only those parts of the curriculum to be changed.

A publisher's claims of standards addressed or recommended grade levels should be viewed with suspicion. Only a careful review will reveal the degree to which the content of standards is actually addressed in instructional materials, or how flexible the recommended grade level may be.

Do not reject too quickly instructional materials packages without certain accessories (e.g., bilingual resources and kits of hands-on materials). Instructional materials with a great deal to offer can be too easily discarded in this way. The most appropriate time to compare such support materials is during the subsequent selection process

STEP 2: TRAINING REVIEWERS

The training of reviewers is an essential step. The goals include developing an understanding of the purpose of the reviews, establishing a common understanding of the role of standards in the review, and fully defining the key terms and criteria to be used in the review. Mock reviews provide the necessary practice, allowing the process outlined in this guide to be adjusted to reflect local needs and values.

The training of the reviewers can also serve to broaden the experiences and background knowledge of the participants, enabling them to envision science education as it could be in local schools, not only as it is. Reviewers should be exposed to recent research in science education content and pedagogy, as well as to outstanding science education programs elsewhere in the nation.

The training process recommended here has been developed through iterative field-test processes. Although the elements have been carefully selected to be those critical for producing a successful review, the facilitator may need to adapt them to meet local needs. Sample agendas, examples, and resources are provided in Chapter 5 "Resources for Training."

Recommended Process

Develop a common understanding of review purpose. The purpose of the review process is improved student science achievement in the near future. The more detail reviewers can bring to their reviews, the more they will be able to make the best choice of instructional materials to meet local needs. In order to provide relevant detail, reviewers will need to develop a common understanding of their work.

First, members of the review team should analyze all the data gathered in Step 1. They should not only discuss the data collected about the effectiveness of the current science education program but also decide on strategies to remedy shortcomings and reinforce strengths. Reviewers should also become familiar with local policies governing the curriculum selection process and reach consensus on any choices that may be open to them about how to proceed.

Develop a depth of knowledge about standards. Each reviewer needs to become familiar with the relevant science content standards (Roseman, 1997a). If the standards document has an overview, that may be a good place to begin. Most standards documents have informative text that precedes the standards, which can provide background information, references to research, and examples of the standards in action.

Be sure that each reviewer understands which part of the main text of the document contains the standards to be used in the review. If your standards are not numbered, a system for referring to an individual standard should be developed (See "Numbering Standards" in Chapter 5).

This may be the first local review to be based on standards or the first experience that individual reviewers have had in applying standards. Reviewers should understand that standards are student learning goals and that the review must determine how likely student are to meet those goals using the instructional materials that will be under review.

Materials do not teach by themselves; so reviewers will need to judge how successfully local teachers will be in using the materials to help students meet learning goals. Reviewers should base their judgments on the explicit guidance and support the materials provide for the teacher — the teacher's guide, lab manual, directions for each lesson, overall format and organization — as well as on the availability of professional development. The reviewers are encouraged to make comments about the knowledge and experience of local teachers in the "Summary Judgment" and "Additional Information" sections of their reviews. The comments recorded for the materials eventually selected will be very helpful to those who plan the professional development that will be required to help the teachers use new materials effectively.

Most instructional material units address more than one content standard, and some will address a standard only partially. The purpose of the review is to evaluate materials against the two to five standards of highest priority. Later, during the selection process, decisions will be made on how best to put together a sequence of instructional materials that meet all student learning goals.

Incorporate the use of selected reference materials. During training activities, introduce reference materials and model their use. The *Standards* (NRC, 1996) are especially helpful in describing inquiry, providing a broad description of each subject area at K-4, 5-8, and 9-12 grades and outlining good science teaching practices. In *Benchmarks* (AAAS, 1993) the chapter format enables a reviewer easily to survey a content area from kindergarten through grade 12. Either *Standards* or *Benchmarks* should be used to supplement local content standards, particularly when the local standards are lists of topics rather than descriptive of what students should understand. In addition, for some content areas, the *Benchmarks*chapter on the research base is a convenient reference on children's ideas and recommended teaching strategies.

Information and reference materials obtained from recent professional development in pedagogical or management areas may be helpful. For example, it may be desirable to consider the compatibility of the reviewed science instructional materials with recommended strategies for planning lessons, using cooperative groups, planning an integrated curriculum, developing language skills in content areas, or addressing the needs of bilingual and special education students.

Information about the mathematics curriculum may be necessary to help reviewers determine whether students' knowledge of mathematics is likely to be consistent with demands of particular science instructional materials.

Introduce the review forms. "Directions for Reviewers" is part of Step 3, and all review forms can be found at the end of this chapter. Form 1 is used to record the standards used for reviewing a specific instructional material, as well as the final rating for how the materials address each standard. Forms 2 and 3 include the six criteria that comprise the review — two on science subject matter, and four on student learning or pedagogy, and are to be filled out for each standard. Form 4 asks the reviewer to provide a summary rating. Form 5 records information from the reviewers on which components offered by the publisher they believe are necessary and the professional development needed to support the use of the materials. (See Figure 1 for an overview of the review process.)

All forms can be found at the end of this chapter. If you wish to customize the review forms just described, an electronic version can be copied from the National Academy Press website (<http://www.nap.edu>). It may be especially important to add to or otherwise revise the directions to include specifics about local meetings, process details, or resources.

Define criteria for student learning. The four student learning criteria in Form 3 of the review tool — active engagement (3.1), depth of understanding (3.2), scientific inquiry (3.3), and assessments (3.4) — must be discussed and described by all reviewers. During field tests of the process provided in this guide, group-generated definitions of these terms produced better and faster reviews than the use of prescribed definitions. A recommended process for generating these definitions is provided in Chapter 5 "Resources for Training."

Record, reproduce, and distribute reviewer-generated definitions of criteria produced during this part of the training. Plan to attach these to each review tool packet for reviewer use during the mock review (see below).

Provide examples of how to cite

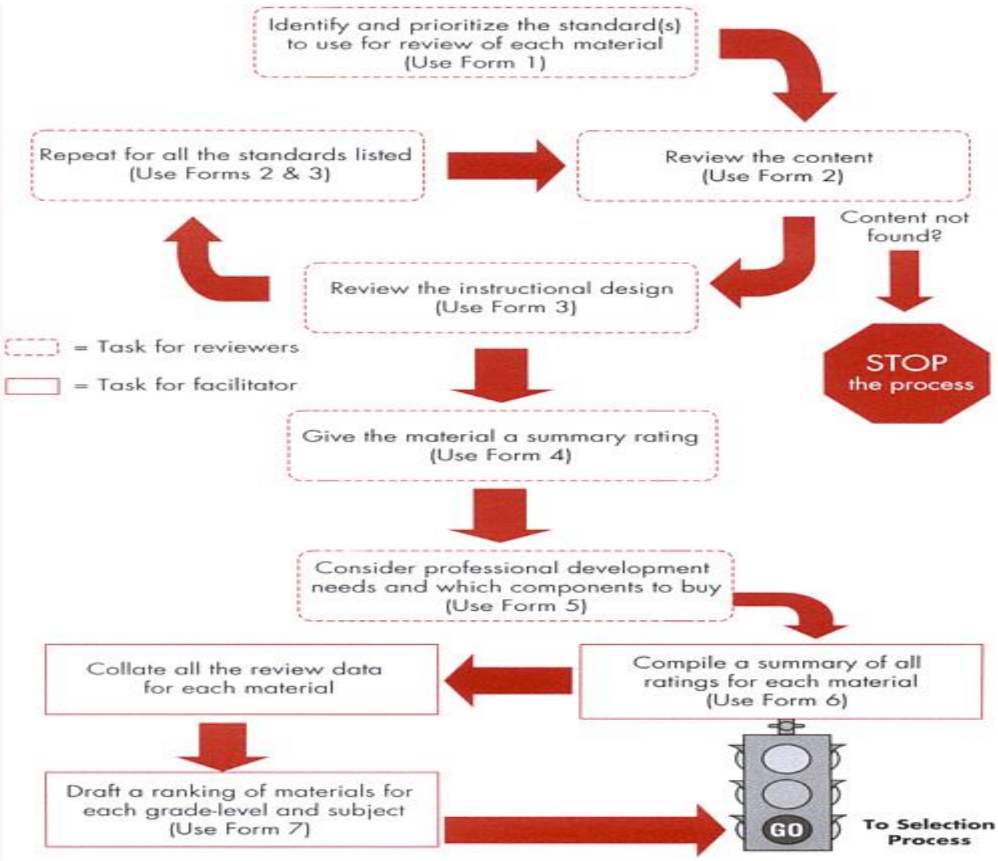


FIGURE 1 Review Process

evidence. The review forms ask reviewers to provide evidence, including examples, explanations, and references, to back up their judgments. Clear and complete citations will be vital to the selection process. Examples of good and poor evidence help reviewers understand what is meant

Practice by doing a mock review. Practice is essential before beginning the actual review. Without it, the first review will become the training experience. For the mock review, choose a sample of high-quality instructional materials of sufficient complexity to simulate actual review challenges. For example, this could be a four-to eight-week module that contains a teacher's guide, student materials, assessments, and optional supplements.

Provide copies of Forms 1-5 of the review forms and "Directions to Reviewers." Depending on your schedule, you can answer any questions the reviewers have on the entire process before they begin their mock review, or you can proceed to answer questions one step at a time.

Have reviewers discuss their results after each section. To resolve concerns, refer back to the worksheets, such as "Definitions of Criteria" and "Directions to Reviewers," and to reference materials. Some calibration of the review process is desirable, and the discussion will be quite helpful to the reviewers. However, complete agreement on how to apply the criteria is not desirable. Diverse individual reviews, guided by the standards and backed up with evidence, will produce the most comprehensive, useful results.

Plan for reflection and evaluation of the process. Convene the reviewers at the end of the process to discuss its benefits and drawbacks and how to improve the process. Sometimes the review participants do not participate in the selection process that follows. If this is so, provide them with information about the future uses of their reviews.

Constraints and Cautions

If training for this process is minimal (for reasons of time or budget, or both, for example), reviewers will be likely to produce widely varying reviews and recommendations, and the result will be a prolonged and possibly confusing selection process.

If your standards document is sketchy, the reviewers may not have sufficient information to understand exactly what students are supposed to know or do to meet the standards**.** This will make review results highly variable. In some cases, the official assessments, used in the region provide more information about what students should know or be able to do. But using assessments as a substitute for standards is risky. The content addressed in assessments is usually quite narrow, and the content or form of the tests may change with little or no notice. If needed and feasible, make a group decision to supplement your standards with the appropriate sections of the *Standards* or *Benchmarks.*

Be alert to the possibility that, while reviewing, reviewers may encounter unfamiliar formats and pedagogical styles. This may cause reviewers to dismiss innovative materials that could be effective (Bush et al., forthcoming).

STEP 3: CARRYING OUT THE REVIEW OF MATERIALS

In Step 3, reviewers identify applicable standards and analyze each potential unit of instructional materials to determine whether the learning goals will be met. The judgments of experienced teachers, informed and focused by training for the process, will be used. The judgments of scientists concerning the accuracy and significance of content and approaches to scientific inquiry — likewise informed and focused by training — will also be harnessed.

You may want to invite others, including school board members and district administrators, to observe the first review session. Doing so will help these key stakeholders become aware of the magnitude of the review task, the qualifications of the reviewers, and the focus on student learning goals. This knowledge will help later on, when these same individuals will be involved in making final decisions, and will help them educate the community about the integrity of the process.

Recommended Process

Make decisions about materials needed, reviewer assignments, and time needed. In assigning materials to reviewer teams, take into account the time required. For planning purposes, estimate that a review of a set of instructional materials covering about eight weeks, against two or three standards, will take at least six hours (when there are two independent reviewers). See also "Budget Planning" in Step 1.

Comprehensive instructional materials packages, such as a yearlong seventh grade science program, will require multiple reviewers. First, decide which standards must be met by the instructional materials and, if feasible, prioritize the standards. Assign each team of two independent reviewers one or two of these standards, which they will then apply in a review of the entire program. This approach ensures that the content coverage and accuracy are given priority. Their review of the student learning criteria should then be carried out for the sections in which their assigned content is found. A conference among all the reviewers is likely to be needed to address overall concerns, such as identification of any gaps, recommended components, and likely needs for professional development. The Review Team Summary (Form 4) will need to be extended to include more standards. In addition, if the reviewers engage in a wide-ranging discussion about the program, it would be helpful to attach a written summary to Form 4.

Each reviewer should be provided with at least the teacher's manual and the assessment materials. For other components, such as materials kits, videotapes, supplementary materials, and student books (if student books are reproduced in the teacher's manual), one set per team may be adequate. When videotapes or other media materials are an integral part of instruction, make the appropriate playback equipment readily available. If materials include software, CD-ROMs, or probeware, it is advisable to have a technical troubleshooter available.

Be sure to communicate to reviewers your arrangements with the publishers, which usually require that the samples be returned promptly in resalable condition.

If you have provided for adequate release time and space, the reviewers will be able to come to a central site to do the reviews. This way, the complete set of materials can be made readily available, but, more importantly, the reviewers will be available to one another. If the reviewers will be working independently off site, plan to facilitate communications with you and with each other. When the reviewers are finished with their individual reviews, you may want to schedule time for a conference among the reviewers of one set of materials. Each reviewer has made independent decisions, but defending those decisions to others and listening to other opinions may strengthen the review process. If there is a broad range of ratings, reviewers should not be pressured to change their original rating unless they find they truly overlooked or misunderstood something. Alternatively, you can convene a conference only when the reviews indicate a need. Looking back on the quality and sources of evidence cited to support an overall judgment should reveal why the reviews differ and will provide discussion points for a conference. In some cases, it may be necessary to carry out another independent review because of disagreements.

Decide who will identify the standards to be used for each unit of instructional materials. This can be done either by you or by the reviewers. If done by you, the review will get off to a faster start. However, this standards selection is a very time-consuming task requiring reading of many materials. Each pair of reviewers assigned a small number of instructional materials can also accomplish the identification and prioritization of standards themselves. Even though it can be a disorienting experience, this approach actually produces more autonomous, flexible reviewers who appear to understand the framework, standards, and their task better. Allow plenty of time and a flexible schedule for this task. (Also see "Directions for Reviewers" below.)

the review. During training, you discussed purpose and walked through a mock review. Now you may want to create a flow chart of all the steps in a review to help keep reviewers oriented. (Also see Figures 1 and 2.) It is not uncommon for reviewers to need guidance about what to do next after having been immersed in the detailed examination of materials. Include directions on how you would like the reports filed and when the reviewers of the same materials may confer.

Conduct the review. Provide each reviewer with necessary tools, including the *Directions to Reviewers,* their criteria definitions, resource materials, and access to all components of the assigned materials. Reiterate how and when to communicate with other reviewers and how to get questions answered.

Compile the review data for each instructional material. Prepare packets of review results for use in the selection process. First, clip together a packet of all review forms for one piece of instructional material from one reviewer. Then gather all reviews for one piece of instructional material and record the results on the Review Team Summary (Form 6). Staple all Form 5 to the back of Form 6. Forms 5 and 6 will be used throughout the selection process. Label and file the individual reviews; they will be needed from time to time in the selection process.

Resolve any discrepant results. When considering multiple reviewer opinions, it is likely that a few will be quite different from the others. Look back through the detailed reviews and let the evidence cited there make the case. At this point, it is possible to disregard a few reviewer decisions if the reviewer did not make a convincing case; but as a general rule, it is better to include than to exclude.

Summarize the results for use in the selection process. This summary is a bridge from the review step to the selection step. You or a small group should apply judgments, make tentative recommendations, and provide a draft of the Selection Recommendations — Form 7 to help get the selection process started.

To do the ranking, look at one program element at a time, such as fifth grade life science or K-2 investigations. Gather the reviews for all instructional materials that may fulfill that program element (some materials will be considered for more than one element). Taking into consideration the opinions and evidence presented by all reviewers, rank the materials from most promising to least promising. Form 7 provides a format for recording this ranked list, with comments. Examples of comments might be "met 4 of the 5 top standards well, professional development is needed to ensure inquiry standards are met," or "7 standards covered — 3 well, 4 incompletely" or "2 of 4 reviewers rated standards achievement 'not at all', content coverage superficial."

Reviewers will not always reach the same conclusions, and may have each made a convincing case for differing conclusions. Carry forward the controversy to the selection process where it can be openly debated and resolved. A carefully designed neutral summary of the reviews will be a helpful addition to the selection recommendations.

This organizing and preliminary ranking will help the launch of "Step 4: Selecting Materials."

Constraints and Cautions

If you have too little time or too few reviewers to handle the number of materials that need to be reviewed, you may need to review the instructional materials by sampling. By confining the review to a sample, you are assuming that the quality of that sample is consistent with the quality of the whole, a risky assumption. If you must sample, choose what to sample with care (i.e., choose the most critical element of study or perhaps the element most in need of improvement in the current program). When sampling, you may want to have reviewers "specialize" in a particular content area or confine their attention to a small set of the standards.

The review process always seems too laborious and lengthy to some reviewers. However, there is simply no substitute for verifying by careful examination that students are likely to achieve the learning goals — the standards — that the teachers and community have agreed are important. At the end of the review process, reviewers state that they understand the science and the science program much better. So, try to keep the reviewers focused on the benefits to the students and to themselves. Provide comfortable accommodations and a lot of positive reinforcement.

If you need to streamline the process, reviewers can review first by one common criterion agreed to be of highest priority. Then a full review can be done only of those materials that passed this initial screening. Applying one screening criterion will work best when there is unanimity among not only reviewers but also the community at large about the attributes of an excellent science curriculum. Rarely is an instructional material review that clear cut, however. Upon closer examination, some of the discarded materials may have positive attributes that outweigh what were initially perceived to be weaknesses.

DIRECTIONS FOR REVIEWERS

1. Identify the standards for reviewing each unit of instructional materials.

The primary source of information will be the curriculum framework, which identifies the standards to be achieved by students in particular grades or grade ranges. For example, a curriculum framework may indicate that sixth grade students will learn about ecosystems and biological adaptations. The standards that describe in detail what middle grade students should understand and be able to do are then the standards applicable to instructional materials under consideration for use for sixth grade life science or integrated science classes.

When looking at unfamiliar instructional materials, it is not always obvious what standards they address. Consult the overview in the teacher's guide, the table of contents, the index, or sales materials from the publisher for topical references. Typically, this method of surveying will result in a very long list of standards that will not necessarily be achieved by the students, but will simply be mentioned or partially addressed. This problem will be addressed for this review by prioritizing the standards and by the recommended method for review

You may discover that the instructional materials under review meet a student learning goal that was not previously identified, but is represented in the standards. Consult other reviewers of the same materials to determine whether this is a high priority standard, and, if so, reviewers can add it to their lists.

2. Prioritize the standards.

There is probably not enough time to complete a review of all the materials using each identified standard. Therefore, with your facilitator or team, make a prioritized list of the standards you will use. Record all these prioritized standards in the table on Standards Record and Rating Sheet (Form 1). Put the highest priority standards first. Use the identification or numbering system agreed to in the training of reviewers.

3. Get ready to conduct the review.

Gather all the components of the materials you will be reviewing, a copy of the standards, as well as reference books on science literacy, science content for various grade levels, and science teaching. You also should have definitions of the criteria developed during your training.

Now, look through the materials, especially overviews in the teacher's sections and sales materials, the table of contents, any assessment materials, and a list of all the components of the set or unit. "Sticky notes" are convenient for marking sections to which you may return. (You should not write on instructional materials under review, because publishers usually ask for their return in salable condition.)

4. Review what students should understand or be able to do.

Make sure that Form 1 contains your name and the title of the unit or set of instructional materials you are reviewing. Now, read the first or highest priority standard and transfer source, grade, and text information about it to the top of Form 2. Now you will begin to do a review, one standard at a time. As you begin, be sure you understand the science content and level of sophistication implied — what students should understand or be able to do. Do not proceed until this is clear to you and your fellow reviewers. Use the content expertise of the scientists on the team and consult your reference books to develop your understanding of what exactly would constitute achieving each standard.

5. Examine the materials for content coverage and scientific accuracy and importance.

Next, examine in detail the materials to look for content coverage and scientific accuracy and importance. Record what you find and where in detail on Form 2. If it turns out that the content of the standard cannot be found in the materials, record why you think so, and give a "not at all" rating for that standard on Form 4 and in the Summary Rating column for that standard on Form 1. Under these circumstances, there is no point in completing Forms 3 and 5.

6. Determine the likelihood the students will learn content.

When the content of the standard is found in the materials, continue to look through the materials for how well and how often the students are engaged in learning about that content. Look also for how well an average teacher would be supported in planning and carrying out the learning experiences. You will be filling out Form 3, using your own judgment and the definitions of the criteria developed during review training. Provide evidence for your conclusions and cite lessons, section numbers, or text, as appropriate.

If instructional materials do not match any standards, but nevertheless seem worthwhile and well designed, you may be confused. In such cases, reviewers often wonder whether the standards are in error. Although this could be the case, usually it is not, and the materials should not be considered for selection. Topics not found in the standards have

usually been intentionally deleted. Also, you may want to refer to standards for other grade levels, since sometimes the topic is found elsewhere and is therefore developmentally inappropriate for the use originally being considered.

Now, make a summary judgment on Form 4 about how likely it is that students would achieve the standard using the unit or set of materials under review. Be sure to give your suggestions for modification or additions as requested. (These will be very helpful in the selection process and for planning professional development if the materials are selected.) Record your rating in the table in Form 1, also. Make notes that will help you complete questions about professional development and essential components in Form 5.

Go back to Form 1 and choose the next standard. Transfer information about that standard to a new set of pages for Forms 2 and 3. Then proceed to judge whether the materials under review contain sufficient amounts of the content in this standard, and so on. When all of the standards listed on Form 1 have been reviewed, complete a summary rating (Form 4).

7. Additional Considerations

On Form 5 you summarize your recommendations for the professional development needed to implement effectively each unit or set of materials you have reviewed. You also identify essential components of the materials needed by the district.

Use a separate Form 5 sheet for each unit or set and be sure to identify at the top which materials you are addressing. When you address professional development, be as specific as possible and apply your knowledge of the level of science background and teaching skills of the "average" teacher. Since you have studied the materials very carefully with student learning in mind, your advice will provide important guidance for those who plan professional development.

Next, you will recommend which components the publisher offers should be purchased, if the materials are selected. Components are parts of the classroom resources that are available separately, such as teacher's guides, student workbooks, videotapes, kits of materials, laser disks, assessment packets, laboratory guides, re-teaching or enrichment materials, and software. List and then rate each, considering its importance to helping students achieve the standards.

What Happens Next?

The facilitator, working with you, will compile a "Review Team Summary" (Form 6), showing how well each reviewed unit or set of instructional materials reflect the prioritized standards. Your judgments recorded on Forms 1-5 will be used in the selection process. Those who ultimately make selection recommendations will use your summary judgments as well as your estimation of the need for professional development and essential components.

STEP 4: SELECTING MATERIALS

To move closer to the goal of making excellent science instructional materials available to students and teachers, the data and judgments collected during review must now be applied to making selections. First, the review data should be compiled and examined. Up to this point, each set of materials was reviewed only against standards. Now, the sets of materials will be compared with one another.

At this time, considerations of cost and professional development likely to be needed for successful implementation are reconciled with resources. Training and supporting the teachers in using the new materials is just as critical to reaching the goal of increased student achievement as choosing good materials.

Finally, another decision-making body, such as a school board, will usually make the final decision about which materials will be purchased. The recommendations developed through the selection process need to make a strong case, citing evidence to support the validity of the process used while focusing on the role of instructional materials in supporting student learning goals.

Recommended Process

Begin the selection process. The review can continue through selection, with the same participants, so that review and selection constitute a seamless process. However, new people will sometimes be involved at this point, due to local decision-making policies or the need to involve other stakeholders, for example. In any case, some review participants should be part of the selection process in order to provide continuity. Any newcomers should be provided with background information about the process so far and engage in a mock review in order to develop understanding of the review data.

Complete the ranking of comparable instructional materials. As described at the end of "Step 3: Reviewing Materials," the selection process begins with examination of a ranked list of instructional materials suitable for a specific grade and content area in the curriculum framework. The recommendations were drafted by the facilitator to help organize the selection process, but should now be examined and revised as necessary. In taking on the selection tasks the participants need to incorporate four elements: (1) review data, (2) information collected in preparing for the review, (3) comparative cost, and (4) professional development requirements.

1. Review data. At the end of the review process, the facilitator will have compiled the ratings of all

reviewers for each set of instructional materials using the Review Team Summary (Form 6). These data should be readily available.

It is sometimes necessary to remind participants that it is not the purpose of the selection process to do another review. Refer them instead to the quality of the evidence given by the reviewers to support their ratings. The selection process should respect reviewer decisions, not undo or redo the reviews.

2. Information collected in preparing for the review. The preparation step yielded important information about the effectiveness of the current program and the opinions of teachers, administrators, and the community about priorities for improving the science program, as well as policies governing the material review and selection process.

Note: To save time, apply elements 3 and 4 (below) only to the top-ranked materials — meaning those under serious consideration.

3. Comparative cost. Using the Comparative Cost Worksheet, calculate a cost per student for each unit or set of promising materials. This exercise should reflect reviewer advice on which parts of the program to buy. These costs are negotiable; so publishers should be consulted before making final recommendations.

4. Professional development requirements. Consider what resources will be needed to train teachers and provide classroom support for effective use of the most promising materials. Again, the reviewer advice should be taken into account, as well as any available information on the plans of those responsible for future professional development. It is highly desirable for the staff responsible for planning and implementing professional development to be part of this discussion.

For an overview of the selection process see Figure 2.

Fit the most promising instructional materials into the curriculum framework. The most desirable instructional materials for each grade and topical area of the curriculum framework have now been tentatively identified. Put those pieces in place in the framework. The final step of the selection process is studying the proposed overall program, and assuring coherence of the materials at each

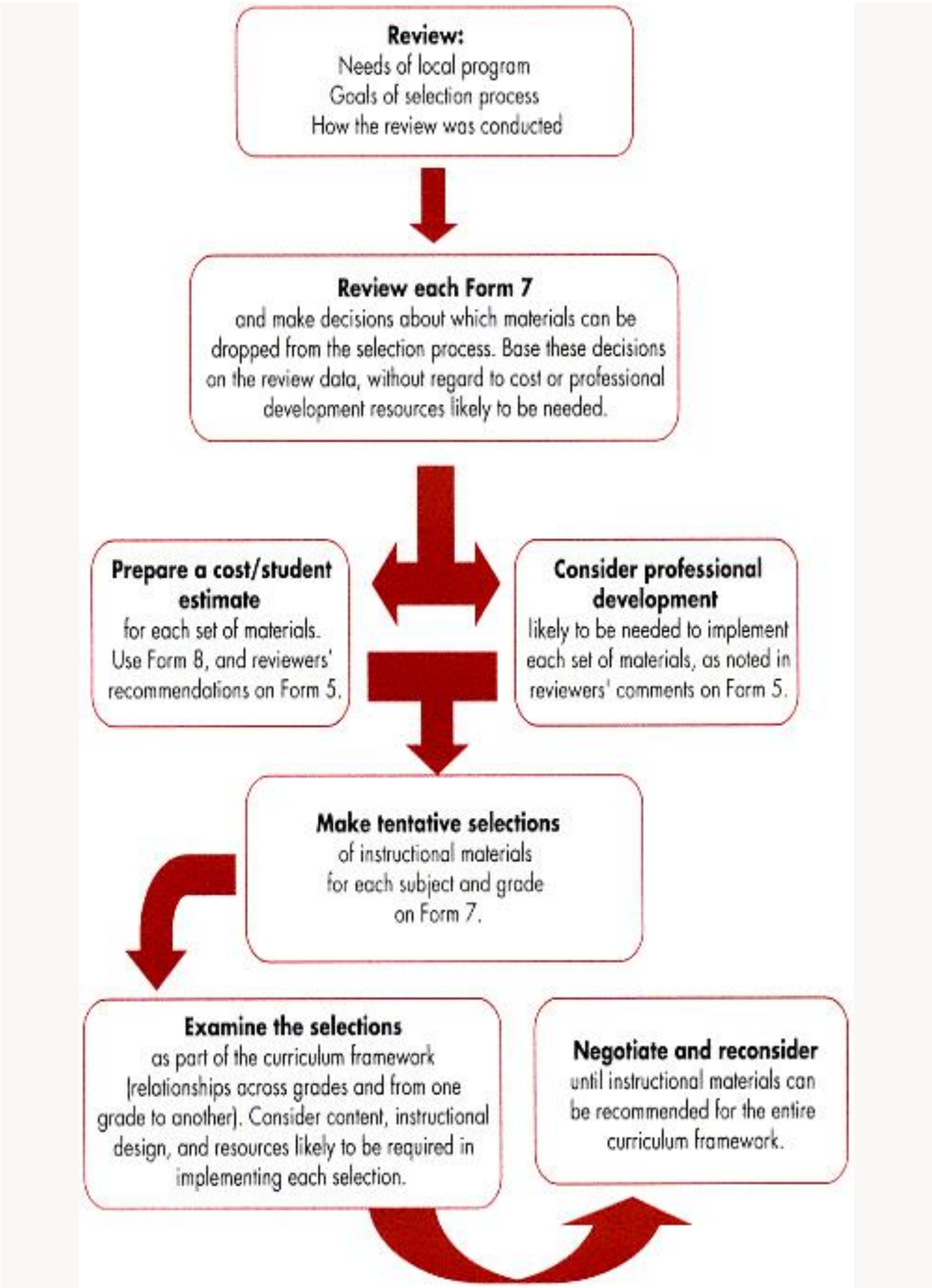


FIGURE 2 Selection Process

grade level and across grade spans, while still meeting overall student learning goals. Making final recommendations, particularly for elementary and middle school, entails a great deal of back-and-forth in search of a coherent arrangement, and it may require some adjustments in the original framework to take advantage of the best curriculum materials that are available.

The selection process may fail to identify materials that address content for each grade level. Solutions include continuing to search for materials to put through an ongoing review, writing new materials from scratch, or attempting to fix materials with poor ratings. Constraints and cautions about local efforts to write or fix materials are discussed below.

Complete the selections. Now you have the product of the entire process — recommended instructional materials chosen for their carefully assessed ability to meet student learning goals. Of course, professional development and ongoing materials management are essential for successful implementation. Be sure to specify the recommended components for each selection (software, laser disk, student workbooks, assessment packets, etc.).

Prepare to present a case for approval. The results of planning, training, reviewing, and selecting now must be approved and implemented. The responsibility of selection participants continues with the requirement to communicate with and persuade decision makers to approve their recommendations. In developing the recommendations report, integrate information about the effectiveness of the current program with how the recommended selections will address related concerns. Point out that the focus of the review was on student learning goals and note any relationships those goals have to current or future achievement tests or graduation requirements. Describe the contacts made with the community and school district administrators, as well as their involvement in the process and any pertinent results or findings. Note the credentials of your reviewers and the extent of their training.

In most localities, an oral presentation will be required — most likely to the school board. Anticipate and prepare to answer questions from school board members, other administrators, and the community. You may want to have summary charts or figures on hand. Have a member of the local scientific community, preferably a member of the review and selection team, speak on behalf of the process and recommendations.

Constraints and Cautions

The selection process may result in recommendations of some instructional

materials with lower than desirable ratings. Unfortunately, high-quality instructional materials may not be available for some student learning goals or an unusual sequence or combination of requirements. These important questions should be taken into account:

- Is it possible that appropriate instructional materials do exist, but were not included in the review? Are potentially suitable materials currently under development? If so, could local schools use the materials in a developer's field test?
- Could it be that the topic is inappropriate for the grade level — too sophisticated or too easy for the average developmental level of students? If so, can the curriculum framework be changed?
- If the final result is a mix of materials from various publishers, is the pedagogy consistent across the materials? Will implementation be unduly confusing? Are copyright infringements a possibility?
- If extensive teacher education will be required, are sufficient resources available: release time, leadership, ongoing support, and evaluation?
- If a local team will need to develop an instructional materials unit, are sufficient human resources — both for teaching strategies and scientific subject matter — available? Are there financial resources to support a sufficiently long period of development, field testing, review, revisions, and publication?
- Could a gap in the program remain until suitable instructional materials can be found through a continuing search and mini-review? How long would local policies allow this condition to exist? Are students at risk of failing to pass required tests or meet prerequisites?

For more information on planning and implementing a science program, see *Designing Mathematics or Science Curriculum Programs: A Guide for Using Mathematics and Science Education Standards* (NRC, 1999a) and *Designs for Science Literacy* (AAAS, forthcoming a).

Be prepared to encounter community opposition, particularly if you have not informed and involved the community adequately. A facilitator with strong knowledge of local and state policy, familiarity with applicable standards, and who can show the strengths of the review and selection process should be sufficiently prepared to handle this situation. Try to avoid polarization by listening carefully and acknowledging opposing concerns. Address opposition by providing evidence from the review process and criteria to back up the recommendations

STEP 5: EVALUATING THE PROCESS AND RESULTS

Developing your local capacity to identify and select instructional materials for the best possible local science program will require several years of effort and ongoing evaluation. As you go through each round of review and selection, lessons learned should be noted and applied to revising the criteria and the processes used. The assumptions and implied goals of the review criteria should be checked against subsequent student achievement and teacher feedback. Having just completed the selection process, you — and participants in the review and selection process — are in a position to recommend ongoing monitoring of the effects and to prepare for the next round. Monitoring may identify the need for supplementation of the choices just made.

Although in many areas the facilitator's job description changes once the science instructional materials are selected — to professional development and implementation concerns or to another subject matter area — continual attention needs to be focused on the efficacy of the new instructional materials. To implement a process of continual improvement, the new program should be monitored in a number of ways, and community involvement should be sustained.

Recommended Process

Gather student achievement data. Review how your district and state will gather data on student achievement with the new materials. The coordination of the implementation of new instructional materials with any new assessment plans, the content of professional development, and knowledge of the political climate will enhance success of the science program (DoEd, 1997a). Analysis of district or state test data, surveys of teachers, and interviews of students can provide evidence of the effectiveness of the materials in helping students achieve the standards.

Also consider more informal opportunities to gather feedback on the science program, such as teacher professional development, meetings of principals, science material distribution centers, a district-wide web site, focus groups, and classroom observations. Keep the focus on standards-based student achievement information, not only to collect convincing data but also to reinforce the message that student achievement is the goal of the science program.

Take another look at the process. If this was not done at the end of the review, reconvene those who were involved in reviewing and selecting the materials to discuss what worked and what did not. Collect their suggestions for future modifications, and with the other key feedback — such as student

achievement — begin preparing for the next review and selection round.

The review and selection teams should also discuss their experiences and recommendations with those responsible for professional development, for developing or revising the curriculum framework, and for refurbishing classroom science materials. This kind of internal communication will help develop the capacity to improve the science program continuously.

Continue to strengthen the program. During review and selection, materials may have been recommended that were not highly rated or that were considered incomplete in terms of helping students achieve relevant standards. Identify who will follow through with the suggestions gathered during review and selection. Because new instructional materials are constantly under development, you may want to schedule periodic mini-reviews to identify new materials to replace or supplement those in place.

Continue community involvement. Community interest in the review and selection process should be nurtured and sustained. Be sure that the community is kept aware of — and involved in — the new program in action. Disseminate information gathered in periodic progress reviews. Establish or strengthen a community advisory board. If the community was not wholly supportive of the process or outcome, begin now to involve key community stakeholders in discussions aimed at preparing for the next round of instructional materials selection.

Constraints and Cautions

The demands of implementing the new program may leave no staff or no time to deal with ongoing evaluation and long-term planning. Experience with the information in this guide should help science program administrators articulate their need to collect evidence of program effectiveness continually, develop capacity to understand the role of standards in the science program, keep the community informed, and plan for future reviews of new instructional materials. Resources for evaluation and long-term planning should be given high priority.

If a demand for evidence of student improvement is made in the first year or two, be prepared for student achievement data to be disappointing. Changes in education practice are multidimensional and require numerous changes, such as new teaching approaches and new kinds of materials. All pertinent aspects must change to significantly affect outcome (Fullan, 1991), and that takes time. Gather baseline data and describe reasonable expectations. Explain long-term evaluation plans and methods.

STANDARDS RECORD AND RATING SHEET **FORM 1**

Title of Instructional Materials: ______________________

Name of Reviewer: ______________________

Use this sheet to record the standards you are using to review the instructional materials, and (after completing Forms 2 and 3) to record how well the materials meet each of those standards. List these standards in order of their priority, with the most important first.

Identify the source(s) for the standards used: ______________________

____

	Grade Level	Identify the Standard *Write a short version and cite a page number from your standards document.*	Summary Rating *(From the end of Form 4).*
1			
2			
3			
4			
5			

CONTENT REVIEW

FORM 2

Title of Instructional Materials: ______________________________

Name of Reviewer: ______________________________

Use a separate set of Forms 2, 3, and 4 for each standard.

Standard # _____
from Form 1

Provide the complete text of the standard

2.1 Is the **content of the standard** found in the materials?
Provide specific evidence, examples, explanations, and references.

2.2 Is the content **scientifically accurate and significant**?
Provide specific evidence, examples, explanations, and references.

Note: *If the content of the materials does not match the standard or is inaccurate or trivial, there is no need to continue the review. Record "not at all" as your summary judgment on Form 4 and in the table on Form 1.*

INSTRUCTIONAL DESIGN REVIEW

FORM 3

Title of Instructional Materials: ______________________________

Name of Reviewer: ______________________________

Standard # ______
from Form 1

Provide the complete text of the standard

3.1 Do the materials **actively engage** the students to promote their understanding of the subject matter of the standard?
Consult the definition developed during review training. Provide specific evidence, examples, explanations, and references. Be sure to consider whether this material provides all students with the opportunity to be actively engaged.

FORM 3 (Continued)

3.2 Will the students develop a **depth of understanding** of the content of the standard through use of the materials?
Consult the definition developed during review training. Provide specific evidence, examples, explanations, and/or references. Be sure to consider whether this material provides all students with the opportunity to develop a depth of understanding.

FORM 3 (Continued)

Note: *SKIP item 3.3 if the standard you are using IS an inquiry standard.*

3.3 Is **scientific inquiry** taught, modeled, and practiced where appropriate? *Consult the definition developed during review training and the inquiry standards. Provide specific evidence, examples, explanations, and references. Be sure to consider whether this material can help all students achieve the standard.*

3.4 Do the materials provide informal and formal **assessments** for both the teacher and student to evaluate progress in achieving the standard?
Provide specific evidence, examples, explanations, and references. Be sure to consider whether the assessments will assist all students in achieving the standard.

SUMMARY RATING

FORM 4

Title of Instructional Materials: ____________________________________

Name of Reviewer: ____________________________________

Standard # ______ *from Form 1*

Use this sheet to provide your summary rating on how well the materials under review will help all students achieve the standard.

_____ **Completely**

_____ **Almost Completely**

Please comment on modifications or additions needed for the material to meet the standard.

_____ **Incompletely**

Please comment on modifications or additions needed for the material to meet the standard.

_____ **Not at all**

Next steps:

- *Record your summary rating in the right-hand column on Form 1.*
- *Continue your review with the next standard on your list from Form 1. Use a new set of Forms 2, 3, and 4.*
- *When you are finished with all the standards on your list, complete Form 5 to finish your review of these materials.*

ADDITIONAL INFORMATION

FORM 5

Title of Instructional Materials: ____________________________________

Name of Reviewer: ____

Complete this after you have completed Forms 2, 3, and 4 with all the standards listed on Form 1.

How much and what kind of **professional development is likely to be needed** by the teachers in order to use these materials effectively?

Most materials are made up of several components (e.g., teacher's manual, materials kit, unit tests, videos, software, enrichment materials). **Which components of the materials under review should be purchased?**

Component	Must have	Optional, high priority	Optional, low priority	Not needed	Not examined

Comments:

REVIEW TEAM SUMMARY

FORM 6

Title of Instructional Materials: ______________________________

Name of Reviewers:

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________

To facilitate the selection process, complete a separate team summary for each unit or set of materials reviewed.

Standard	**Rating of each reviewer** 1	2	3	4

For ease in scanning the columns, use these codes:

C = completely

AC = almost completely

I = incompletely

N = not at all

SELECTION RECOMMENDATIONS

FORM 7

Grade Level and Subject: ______________________________

(e.g., third grade physical science)

	Title and publisher	Comments
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		

Computer Assisted Instruction
Computer Assisted Instruction (CAI) is defined as the use of computers and software applications to teach concepts or skills. IBM developed one of the first instructional computer systems in the 1960s using **minicomputers**. From the 1960s to the 1980s, IBM produced a handful of these 1500 series computers for the military and several universities. These units, contained in special trailers, consisted of complete workstations: one large **central processing unit (CPU)**, one instructor's station, and sixteen student terminals. The trailer was hauled from place to place as needed.

Pennsylvania State University and the University of Alberta (Canada) were two of the biggest advocates of the 1500 series stations and provided a great deal of early research on computer assisted instruction. Researchers from several universities, such as from the University of Pittsburgh's Learning Research and Development Center (LRDC), continue the effort to identify the best methods and tools for using interactive computer programs to enhance learning.

Computer assisted instruction has changed radically since the 1500 series. Computers are found in a growing number of homes and schools, and a variety of applications exist to use the computer to teach. The military has continued to be a significant advocate of computer assisted instruction to teach large numbers of trainees a multitude of jobs, including teaching pilots how to fly with the use of flight simulators. Without question, "e-learning" is a growing economic sector. In 2000, e-learning (electronic-learning) was a $2.2 billion dollar business. By 2003, it is expected to be worth $11.4 billion.

Learning Management Systems
One growing trend among schools is to use a powerful application called a Learning Management System (LMS). Some companies that sell LMSs provide a service to the schools. Students, using either the school-owned computers or computers in the schools provided by the company, connect to the service's web site to access a curriculum chosen by the faculty. The students access the educational resources for a specific period of time over a specific number of weeks; the frequency and duration vary from program to program.

The advantages of using an LMS are compelling. Many students are eager to use such a site because of its "cool factor," which may motivate them to do well. The curriculum can be adjusted to focus on specific areas of weakness, whether for the entire class or for an individual. Any or all students can be monitored for progress.

Among the disadvantages to implement an LMS, schools must have a reliable Internet system installed, which can be a major and expensive project. Another disadvantage is that the programs themselves can cost up to $30,000, a price that might not include the cost of computers. The effectiveness of these programs, as compared to conventional instruction, is also still open to debate among critics and proponents of learning management systems.

A variety of LMSs are available from different manufacturers. Choosing among them can be quite difficult, as they have considerable variation of methodology and depth. They also work on several different hardware platforms. Construction of each course must be done on an individual basis, and so there are no "plug and play" options. Also, there are no universally accepted standards to compare programs. The Shared Content Object Reference Model, or SCORM (developed by the U.S. government), is one set of standards gaining acceptance.

Electronic Books

Electronic books, especially electronic textbooks, are another form of computer assisted instruction. E-textbooks offer several advantages over print textbooks. They can be updated quickly and easily at a far cheaper price than conventional textbooks. Complex images and concepts, such as molecular biology, can be illustrated in interactive, three-dimensional presentations, instead of traditional drawings or photographs on paper, to aid in understanding. A laptop computer, to which e-textbooks can be downloaded, weighs a fraction of several paper textbooks and occupies less space. Their use would address the growing concern about overweight backpacks for students of varying ages. Teachers could cut and paste curriculum text in a customized format for students. Assignments and homework could be posted on a server. Such a system would need little introduction or training for students, so many of whom are already media savvy and using online resources for learning-related activities.

There are drawbacks to using e-textbooks, however. The initial investment of computers and software can be costly. In some programs, graphics (such as maps, charts, graphs, and pies) might not be accessible. Compatibility of programs with other learning software might be a problem. However, despite these concerns, some experts predict that the sales of e-textbooks will net $3.2 billion in 2005, and will consist of 25 percent of all textbook sales by that time.

Electronic Performance Support Systems

Electronic Performance Support Systems, or EPSS, is another form of computer assisted instruction. Gloria Gery, an educational software expert in Tolland, Massachusetts, began developing EPSS in the early 1990s. The purpose of EPSS is to help automate a job. TurboTax is an example of an EPSS. Once the program is started, the user is prompted to answer a series of financial questions. When finished, the program computes the complete tax return for the user. The program can print out a copy of the results for the user, and if directed to do so, will even send an electronic copy to the Internal Revenue Service (IRS).

EPSS has found uses in many fields. Auto mechanics use an EPSS to diagnose car trouble. Travel agents make reservations with one. Cornerstone, an EPSS used by the NASD (a Wall Street self-regulatory organization) helps auditors do their jobs. The sale and leasing of cars is simplified with the help of an EPSS.

People often believe their jobs are too creative or complex for EPSS, but in many cases they are mistaken. In jobs that require human judgment, EPSS offers a series of alternatives to which the user can refer. As a result, employees can assume more complex job responsibilities after much shorter training periods and with significantly higher accuracy than would be likely with traditional training or job support structures. Hiring employees becomes cheaper. Because employees do not need to be so highly trained, the pool of applicants is much bigger, which is a benefit for employers. There is a downside to EPSS. The reduced need for better-educated individuals and shorter training periods could reduce the need for highly educated employees, resulting in lower salaries in many job categories.

Use of computer in education is referred by many names such as

- Computer Assisted Instruction (CAI)
- Computer Aided Instruction (CAI)
- Computer Assisted Learning (CAL)
- Computer Based Education (CBE)
- Computer Based Instruction (CBI)
- Computer Enriched Instruction (CEI)
- Computer Managed Instruction (CMI)

New Terminology

- Web Based Training

• Web Based Learning

• Web Based Instruction

Computer-based education (CBE) and computer-based instruction (CBI) are the broadest terms and can refer to virtually any kind of computer use in educational settings. Computer-assisted instruction (CAI) Computer Aided Instruction (CAI) is a narrower term and most often refers to drill-and-practice, tutorial, or simulation activities. Computer-managed instruction (CMI) Computer-managed instruction is an instructional strategy whereby the computer is used to provide learning objectives, learning resources, record keeping, progress tracking, and assessment of learner performance. Computer based tools and applications are used to assist the teacher or school administrator in the management of the learner and instructional process.

Computer Assisted Instruction (CAI)

A self-learning technique, usually offline/online, involving interaction of the student with programmed instructional materials.

Computer-assisted instruction (CAI) is an interactive instructional technique whereby a computer is used to present the instructional material and monitor the learning that takes place.

CAI uses a combination of text, graphics, sound and video in enhancing the learning process. The computer has many purposes in the classroom, and it can be utilized to help a student in all areas of the curriculum.

CAI refers to the use of the computer as a tool to facilitate and improve instruction. CAI programs use tutorials, drill and practice, simulation, and problem solving approaches to present topics, and they test the student's understanding.

Typical CAI provides

1. text or multimedia content
2. multiple-choice questions
3. problems
4. immediate feedback
5. notes on incorrect responses
6. summarizes students' performance
7. exercises for practice
8. Worksheets and tests.

Types of Computer Assisted Instruction

1. Drill-and-practice Drill and practice provide opportunities or students to repeatedly practice the skills that have previously been presented and that further practice is necessary for mastery.

2. Tutorial Tutorial activity includes both the presentation of information and its extension into different forms of work, including drill and practice, games and simulation.

3. Games Game software often creates a contest to achieve the highest score and either beat others or beat the computer.

4. Simulation Simulation software can provide an approximation of reality that does not require the expense of real life or its risks.

5. Discovery Discovery approach provides a large database of information specific to a course or content area and challenges the learner to analyze, compare, infer and evaluate based on their explorations of the data.

6. Problem Solving This approach helps children develop specific problem-solving skills and strategies.

Advantages of CAI

- one-to-one interaction
- great motivator
- freedom to experiment with different options
- instantaneous response/immediate feedback to the answers elicited
- Self pacing - allow students to proceed at their own pace
- Helps teacher can devote more time to individual students
- Privacy helps the shy and slow learner to learns
- Individual attention
- learn more and more rapidly
- multimedia helps to understand difficult concepts through multi sensory approach
- self-directed learning – students can decide when, where, and what to learn

Limitations of CAI

- may feel overwhelmed by the information and resources available
- over use of multimedia may divert the attention from the content

- learning becomes too mechanical
- non-availability of good CAI packages
- lack of infrastructure

The Teacher's Role in Effective Computer-Assisted Instruction Intervention. An understanding of the teacher's role in a classroom in which CAI is used is essential to meeting the needs of reluctant learners.

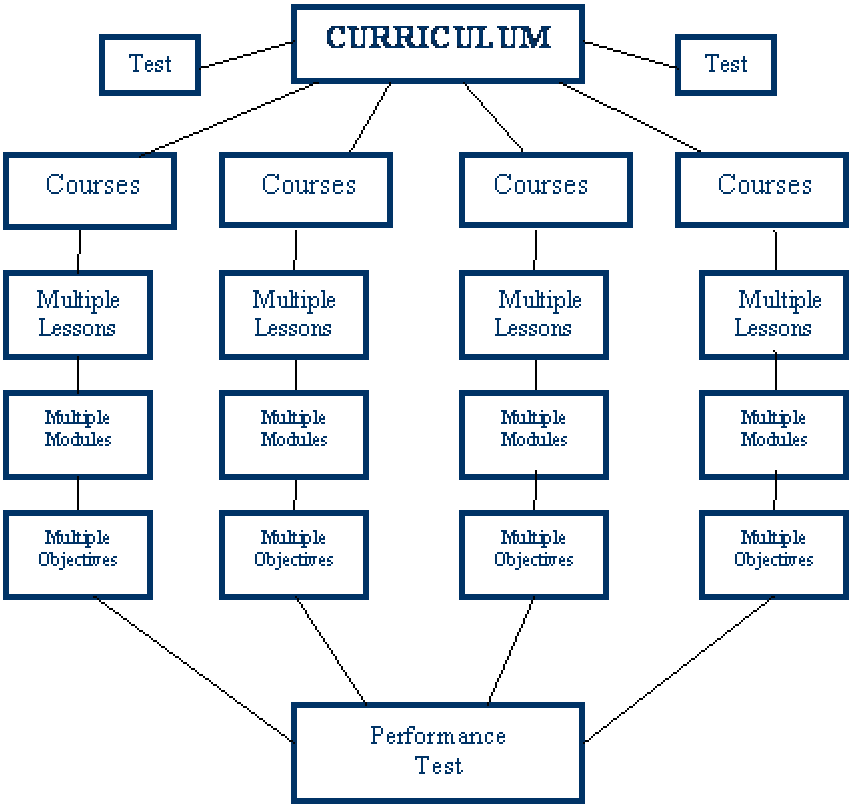
The use of Computer-Aided Instruction (CAI) in schools has become an important topic of research among educators with the widespread availability of microcomputers to aid teachers and students in their teaching and learning process.

Lesson Development
A lesson plan is a teacher's detailed description of the course of instruction or "learning trajectory" for a lesson. A daily lesson plan is developed by a teacher to guide class learning.

Good lesson planning is essential to the process of teaching and learning. A teacher who is prepared is well on his/her way to a successful instructional experience. ... There is a large body of research available pertaining to lesson development and delivery and the significance of classroom management.

EFFECTIVE LESSON PLANNING.
Good **lesson** planning is essential to the process of teaching and learning. A teacher who is prepared is well on his/her way to a successful instructional experience.

Computer Managed Instruction (CMI)
A term employed to designate a system which " uses the computer to help the teacher administer and guide the instructional process." The major features of CMI are diagnosis and testing, analysis, record keeping, and prescription.



Example of CMI

The Benefits and Limitations of CMI

With the flexibility of CMI systems, the instructor can choose appropriate objectives and activities in the curriculum based on a specific student's needs. If it is conducive to the subject, the student can also decide in which order to meet the objectives. The sequence of modules is flexible. The student can also study and progress at his or her own pace as the CMI system is basically instructor-free.

The limitation of this type of system is the need for a central computer system that would allow the instructor to identify and control the student's activities in different locations at different times. With the expansion of cable modems and DSL, this limitation is steadily becoming a non-issue, except in remote areas.

As technology increases, more and more individuals will have the benefit of a CMI system as an option for training. Since it is a system that is geared more toward a student's abilities than other standard educational systems, it can prove to be a more beneficial type of training.

Computer-managed instruction is an instructional strategy whereby thecomputer is used to provide learning objectives, learning resources, and assessment of learner performance. Computer-managed instruction (CMI) aids the instructor in instructional management without actually doing the teaching.

A **deductive approach** involves the learners being given a general rule, which is then applied to specific language examples and honed through practice exercises.

A deductive approach to teaching language starts by giving learners rules, then examples, then practice. It is a teacher-centred approach to presenting new content. This is compared with an inductive approach, which starts with examples and asks learners to find rules, and hence is more learner-centred.

An **inductive approach** involves the learners detecting, or noticing, patterns and working out a 'rule' for themselves before they practise the language

Two very distinct and opposing **instructional** approaches are **inductive and deductive**. Both approaches can offer certain advantages, but the biggest difference is the role of the **teacher**. Conversely, **inductive instruction** is a much more student-centered approach and makes use of a strategy known as 'noticing'.

Unit V: Evaluation, Planning and Maintenance of Computer Laboratory

Need for planning the computer Laboratory

A computer lab is a space which provides computer services to a defined community. Computer labs are typically provided by libraries to the public, by academic institutions to students who attend the institution, or by other institutions to the public or to people affiliated with that institution. Users typically must follow a certain user policy to retain access to the computers. This generally consists of the user not engaging in illegal activities or

attempting to circumvent any security or content-control software while using the computers.[1] In public settings, computer lab users are often subject to time limits, in order to allow more people a chance to use the lab, whereas in other institutions, computer access typically requires valid personal login credentials,[1] which may also allow the institution to track the user's activities. Computers in computer labs are typically equipped with internet access, while scanners and printers may augment the lab setup. Computers in computer labs are typically arranged either in rows, so that every workstation has a similar view of one end of the room to facilitate lecturing or presentations,[2] or in clusters, to facilitate small group work.[3] In some cases, generally in academic institutions, student laptopsor laptop carts[4] take the place of dedicated computer labs, although computer labs still have a place in applications requiring special software or hardware not practically implementable in personal computers.

10 Important Rules for Your School's Computer Lab

We love education technology here on Edudemic. From the looks of it, you like it too. So let's stop for a second and forget the idea of a 1:1 classroom or a BYOD setup. Let's take a walk down the hall together and stop in at the school computer lab. It's filled with ~~brand new~~ barely working computers. They are there for a reason: to help students access the web and learn together. Computer labs can be a hotbed of activity or they can be something that resembles a graveyard. It's up to your school to determine which you want.

Every school is different so these rules are not perfect for everyone. However, at least some of them are quite useful. For example, 'print only when necessary' is a great tip that is eco-friendly and saves your school a bit of coin on printing costs.

On the other hand, 'work quietly' may not suit every school's computer lab. As I mentioned above, these are labs, not libraries. It can be okay to do group work or to have some collaborative project-based learning in the lab. Again (can't stress this enough), it's up to every individual school to determine the proper rules for a classroom / school computer lab.

The following list of 10 rules are succinct and meant to be printed out and posted on your lab's walls. They may not have much description to go along with each rule, but it's a great starting point.

Personally, I think the 'surf safely' rule is most important. Honestly, it's more important than working quietly or (heaven forbid!) not changing settings on a computer. Most of the technical stuff can be accomplished using preventive software or parental controls (like on an iPad). But the 'surf safely' (shouldn't it be 'safely surf?') rule is key because it brings to mind the idea of digital citizenship. To give you a quick idea of what I mean, digital citizenship means you should be aware that your information is public, everything you do online is public, and that you will be held accountable for any action you take.

What are the main features of an accessible computer lab?

Designing a lab that is universally accessible begins with the physical environment of the facility. Considerations for making a computer lab facility more accessible include the following:

- Make sure doorway openings are at least 32 inches wide and doorway thresholds are no higher than 1/2 inch.
- Keep aisles wide and clear for wheelchair users. Have protruding objects removed or minimized for the safety of users who are visually impaired.
- Make sure all levels of the lab are connected by a wheelchair-accessible route of travel.
- For students with mobility impairments, make sure there are procedures in place for retrieving materials that may be inaccessible.
- Make sure ramps and/or elevators are provided as an alternative to stairs. Elevators should have both auditory and visual signals for floors. Elevator buttons should be marked in large print and Braille or raised notation and easily reachable for wheelchair users.
- Locate the lab near wheelchair-accessible restrooms with well-marked signs.
- Service desks need to be wheelchair-accessible.
- Provide ample, high-contrast, large-print directional signs throughout the lab. Mark equipment in the same fashion.
- Provide study carrels, hearing protectors, or private study rooms for users who are easily distracted by noise and movement around them.
- Provide at least one adjustable-height table with easily reachable controls for each type of computer.
- Have wrist rests available to those who require extra wrist support while typing.
- Keep document holders available to help users position documents for easy reading

A laboratory notebook (colloq. lab notebook or lab book) is a primary record of research. Researchers use a lab notebook to document their hypotheses, experiments and initial analysis or interpretation of these experiments.

Types of record found within the collections

A wealth of different types of archival record are found within family and estate collections, though because of the wide variety in geographical and chronological coverage, not every collection will contain every record type.

Some of the most significant record types are:

- Property records - title deeds and settlements
- Accounting papers - including rentals, vouchers, surveys and valuations
- Legal papers
- Inventories
- Correspondence
- Enclosure papers
- Manorial papers - court rolls, custumals, terriers, surveys etc
- Personal and political papers
- Maps and plans

To assist users in interpreting these record types, Manuscripts and Special Collections is developing a series of Skills Resources. Links to the Skills Resources will be added here as each successive set becomes available

COMPUTER LAB RULES

1. Always bring pencil and paper to class and binder.
2. Be in your seat and ready to work by the tardy bell.
3. Go to the restroom before class and after class. If you have to go during class, you must stay in at break.
4. If you need to speak, raise your hand and wait to be recognized by the teacher.
5. Do not disturb the class.
6. No food or drinks are allowed in the computer lab.
7. Do not lay back or roll around in the chairs.
8. Do not put on screen savers.
9. Do not change any computer settings.
10. Do not download anything without permission.
11. Do not go online without permission.

Preparation for Lab

- Pre-teach in classroom so computer time is used most efficiently.
- Teachers are in charge of teaching the class and discipline.
- Teachers should review, with their students, the district's Electronic Communication and Data Management Policy, included in the Student Code of Conduct booklet.
- It is the teacher's responsibility to verify that students have permission to use computers and/or the Internet.
- Teacher must remain in the lab at all times.
- Teachers are required to show computer time in their lesson plans.

- Teachers are required to have a student seating chart and provide a copy to the Media Center. Students must always sit at the same computer. If a change is made, for any reason, the seating chart must be changed.
- Students should work quietly at their own computer.
- Computer volume level should be left at 40 or below or off.
- Students should not change any computer settings (desktop, screen saver, etc.)

General Procedures

- Students should leave backpacks in classroom.
- Teachers/students will turn computers on in the morning and the last class of the day will be expected to shut them down.
- Teachers are expected to closely monitor student activity by frequent screen checks. If using the Internet--use URL's that you have visited and are appropriate for the assignment.
- Students must save to their floppy drive and not the hard drive. Saving to the hard drive will cause the student to lose all of their work.
- Make sure students only send the print command to the printer one time. If it is not printing, there is a reason.
- Before leaving the computer lab, students must close all open windows, applications and log out.
- We will adhere to copyright laws.
- Do not unplug and switch mouse for lefthanded students. Simply have student move mouse to left side of keyboard and replace on right side when they leave the lab.
- Student teachers are not to be left in charge of the computer lab. Teacher must be present.
- Substitute teachers will not be allowed to take classes to the computer lab.

Note: Please keep some of the wonderful things the students will be creating so that we can turn them into the district to show how we are using our technology. (We can save work onto a disk on the spot!)

Computer Lab Rules

1. Handle ALL EQUIPMENT properly and with respect.
2. Act appropriately at all times & be courteous to others.
3. No gum, food, or drinks in lab.
4. No backpacks or personal CD's.

5. Stay at your assigned computer.
6. Talk only when necessary & then quietly so you don't disturb others.
7. Don't waste time!--Yours or your friends.
8. Visit only approved or appropriate Internet sites for your assignment.
9. No "Surfing the Net".
10. Leave computer volume level at or below 40 or off.
11. Do not make any changes to computer settings. (This includes desktop, screen saver, etc.)
12. Students are expected to follow the District's Electronic Communication and Data Management Policy (Acceptable Use Policy).

COMPUTER LAB EQUIPMENT CARE

Students will be responsible for the proper use and care of their assigned computer. In order to assure that the computers are maintained properly, students will be expected to observe the following rules:

1.Press keys lightly on keyboard and only with fingers.
2.Keep computer mouse on the mouse pad.
3.Keep keyboard on table--not lap.
4.Keep hands and fingers off face of monitor to avoid scratching & smudging.
5.Never leave anything taped to monitor. Post it notes may be left on the casing of the computer.
6.Send a NOTICE to the Media Center immediately if you encounter any problem with a computer.

Evaluation is a **process** that critically examines a program. It involves collecting and analyzing information about a program's activities, characteristics, and outcomes. Its purpose is to make judgments about a program, to improve its effectiveness, and/or to inform programming decisions

The eight elements to any evaluation plan are:

- Purpose. Why is the evaluation being conducted?
- Audience. Who are the target recipients of the evaluation results?
- Issues. What are the major questions/objectives of the evaluation?
- Resources.
- Evidence.
- Data-gathering Techniques.

- Analysis.
- Reporting.

THE 12 KEY COMPONENTS OF M&E SYSTEMS

Monitoring and Evaluation Systems require twelve main components in order to function effectively and efficiently to achieve the desired results. These twelve M&E components are discussed in detail below:

1. Organizational Structures with M&E Functions

The adequate implementation of M&E at any level requires that there is a unit whose main purpose is to coordinate all the M&E functions at its level. While some entities prefer to have an internal organ to oversee its M&E functions, others prefer to outsource such services. This component of M&E emphasizes the need for M&E unit within the organization, how elaborate its roles are defined, how adequately its roles are supported by the organizations hierarchy and how other units within the organization are aligned to support the M&E functions within the organization.

2. Human Capacity for M&E

An effective M&E implementation requires that there is only adequate staff employed in the M&E unit, but also that the staff within this unit have the necessary M&E technical know-how and experience. As such, this component emphasizes the need to have the necessary human resource that can run the M&E function by hiring employees who have adequate knowledge and experience in M&E implementation, while at the same time ensuring that the M&E capacity of these employees are continuously developed through training and other capacity building initiatives to ensure that they keep up with current and emerging trends in the field.

3. Partnerships for Planning, Coordinating and Managing the M&E System

A prerequisite for successful M&E systems whether at organizational or national levels is the existence of M&E partnerships. Partnerships for M&E systems are for organizations because they complement the organization's M&E efforts in the M&E process and they act as a source of verification for whether M&E functions align to intended objectives. They also serve auditing purposes where line ministries, technical working groups, communities and other stakeholders are able to compare M&E outputs with reported outputs.

4. M&E frameworks/Logical Framework

The M&E framework outlines the objectives, inputs, outputs and outcomes of the intended project and the indicators that will be used to measure all these. It also outlines the assumptions that the M&E system will adopt. The M&E framework is essential as it links the objectives with the process and enables the M&E expert know what to measure and how to measure it.

5. M&E Work Plan and costs

Closely related to the M&E frameworks is the M&E Work plan and costs. While the framework outlines objectives, inputs, outputs and outcomes of the intended project, the work plan outlines how the resources that have been allocated for the M&E functions will be used to achieve the goals of M&E. The work plan shows how personnel, time, materials and money will be used to achieve the set M&E functions.

6. Communication, Advocacy and Culture for M&E

This refers to the presence of policies and strategies within the organization to promote M&E functions. Without continuous communication and advocacy initiatives within the organization to promote M&E, it is difficult to entrench the M&E culture within the organization. Such communication and strategies need to be supported by the organizations hierarchy. The existence of an organizational M&E policy, together with the continuous use of the M&E system outputs on communication channels are some of the ways of improving communication, advocacy and culture for M&E

7. Routine Programme Monitoring

M&E consists of two major aspects: monitoring and evaluation. This component emphasizes the importance of monitoring. Monitoring refers to the continuous and routine data collection that takes place during project implementation. Data needs to be collected and reported on a continuous basis to show whether the project activities are driving towards meeting the set objectives. They also need to be integrated into the program activities for routine gathering and analysis.

8. Surveys and Surveillance

This involves majorly the national level M&E plans and entails how frequently relevant national surveys are conducted in the country. National surveys and surveillance needs to be conducted frequently and used to evaluate progress of related projects. For example, for HIV and AIDS national M&E plans, there needs to be HIV related surveys carried at last bi-annually and used to measure HIV indicators at the national level.

9. National and Sub-national databases

The data world is gradually becoming open source. More and more entities are seeking data that are relevant for their purposes. The need for M&E systems to make data available can therefore not be over-emphasized. This implies that M&E systems need to develop strategies of submitting relevant, reliable and valid data to national and sub-national databases.

10. Supportive Supervision and Data Auditing

Every M&E system needs a plan for supervision and data auditing. Supportive supervision implies that an individual or organization is able to supervise regularly the M&E processes in such a way that the supervisor offers suggestions on ways of improvement. Data auditing implies that the data is subjected to verification to ensure its reliability and validity. Supportive supervision is important since it ensures the M&E process is run efficiently, while data auditing is crucial since all project decisions are based on the data collected.

11. Evaluation and Research

One aspect of M&E is research. The other is evaluation. Evaluation of projects is done at specific times most often mid- term and at the end of the project. Evaluation is an important component of M&E as it establishes whether the project has met he desired objectives. It usually provides for organizational learning and sharing of successes with other stakeholders.

12. Data Dissemination and Use

The information that is gathered during the project implementation phase needs to be used to inform future activities, either to reinforce the implemented strategy or to change it. Additionally, results of both monitoring and evaluation outputs need to be shared out to relevant stakeholders for accountability purposes. Organizations must therefore ensure that there is an information dissemination plan either in the M&E plan, Work plan or both.

Objective-based: **Evaluation** as a process of determining the degree to which educational **objectives** are being achieved.

Value-**based**: **Evaluation** is not only concerned with goals, but also whether the goals are worth achieving.

Tools and Techniques of Evaluation

A tool maybe defined as an instrument or implement that facilitates the work of the d and the eye. It is in some sort of manual work that we need to use certain tool or tools. In a manual operation, the use of a tool marks the performance of the operation easy and better then otherwise. A tool of evaluation as used in education is a device or technique that will facilitate the process of measuring and recording the characteristics of pupils. Tools of evaluation are sophisticated techniques of appraisal, intelligently designed to measure what is required to be measured. To-day's evaluator makes use of many techniques which lend efficiency and authenticity to his appraisal of his pupil. "Modern evaluation uses a variety of techniques of appraisal such as achievement, attitude, personality and character tests rating scales, questionnaires, judgement scales of products, interviews, controlled observation techniques, sociometric technique and anecdotal records".

Teacher Training Diploma has discussed the use of the following tools of evaluation:

1. Paper-Pencil Tests: Tests and examinations have been regarded as the major tools of evaluation. For that reason, teacher's estimate based on paper and pencil tests was accepted as the sole measure of a pupil's ability or achievement. Though studies with regard to the reliability and validity of teacher-made tests have posed a serious doubt on their accuracy, yet these paper and pencil tests continue to be used in our schools and colleges without any regard to other evaluative devices or techniques.

Paper and pencil or written tests may be:

- Essay-type or Long-answer Type Tests
- (ii) Short-answer Type Tests
- (iii) Objective Type Tests

2. Questionnaires: A questionnaire is a useful tool of evaluation. A large amount of data on various aspects of the theme in hand can be collected and the respondent (the person upon whom the questionnaire is administered) can be evaluated accordingly. Questionnaire refers to a device for securing answers to questions by using a form which the respondent files himself'. Questionnaire is systematic compilation of questions that are submitted to a sampling of population from which the information is desired.

While compiling a questionnaire for collecting some relevant information, the following points should be considered:

- It should have a definite purpose.
- The questions should be worded in simple and distinct language.
- The questionnaire should be of reasonable length. This does not irritate.
- It must be preceded by clear and complete direction for the respondent to give proper answers.

- The questions should ask what is desired to be asked. Off-the-point questions should be avoided.
- The form of the questionnaire – ‘Closed Form” (in which response is restricted to `Yes’ or `No’) or ‘Open Form’ (in which free response can be given) – should be carefully selected according to the purpose.
- The questionnaire should be easy to tabulate and interpret. The information collected with the help ofa questionnaire maybe used for evaluating personality traits, interests, opinions, likes and dislikes. This type of data is very useful in providing counselling.

3. Observation: Observation of the pupil’s behaviour is an important technique of gathering information for the purpose of evaluation. Observation is as primitive a procedure as it is modem and new, with many new techniques being used as observation procedures. It is a tool by which the external behaviour of a person/persons in controlled or uncontrolled situations can be observed and recorded. Though observation is the most widely used of all measurement procedures, yet it is “measurement without instrument”. Observation is an attempt to observe and appraise whatever happens, as it happens. In fact, teachers are ever observing their pupil’s behaviour. They also give their interpretations of the incidents they observe. But these interpretations are not always objective. In spite of this, observation is a common technique used by teachers to collect data relating to human behaviour. In educational evaluation, observation is the most widely used of all measurement procedures. This is so, perhaps, because a number of behavioural phenomena may not be assessed validity by another procedure.

   The two commonly used methods of observation are:

   - Directed observation
   - The anecdotal method

Norm-referenced tests report whether test takers performed better or worse than a hypothetical average student, which is determined by comparing scores against the performance results of a statistically selected group of test takers, typically of the same age or grade level, who have already taken the exam.

Criterion-referenced tests and **assessments** are designed to measure student performance against a fixed set of predetermined **criteria** or learning standards—i.e., concise, written descriptions of what students are expected to know and be able to do at a specific stage of their education

Criterion-referenced means the **test** relates to some sort of established unit of measure. DORA is **criterion-referenced** because it reports in grade level equivalent scores. For example, John's phonics skills are low 4th grade level. **Norm-referenced** is a percentage ranking compared to an average population

Test construction is the set of activities involved in developing and evaluating a **test** of some psychological function.

A **test item** is a specific task **test** taker are asked to perform. **Test items** can assess one or more points or objectives, and the actual **item** itself may take on a different constellation depending on the context.

Construct **validity** is "the degree to which a **test** measures what it claims, or purports, to be measuring." Construct **validity** is the appropriateness of inferences made on the basis of observations or measurements (often **test** scores), specifically whether a **test** measures the intended construct.

A **standardized test** is any form of **test** that

(1) requires all **test** takers to answer the same questions, or a selection of questions from common bank of questions, in the same way, and that

(2) is scored in a “standard” or consistent manner, which **makes** it possible to compare the relative performance of individual

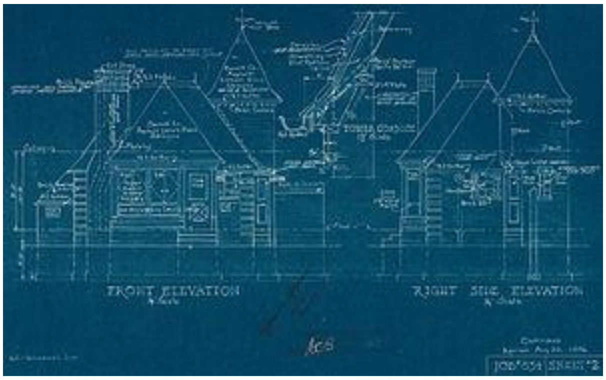
Principles of Test Construction

Test construction requires a systematic organized approach if positive results are to be expected. Firstly, the objective must be well defined. There are numerous points which are common to all types of tests and items which must be observed in constructing a test. Some of the more important are given below

1. Avoid obvious, trivial, meaningless and ambigjous items;

2.Observe the rules of rhetoric, grammar and punctuation;

3. Avoid items that have no answer upon which all experts will agree;



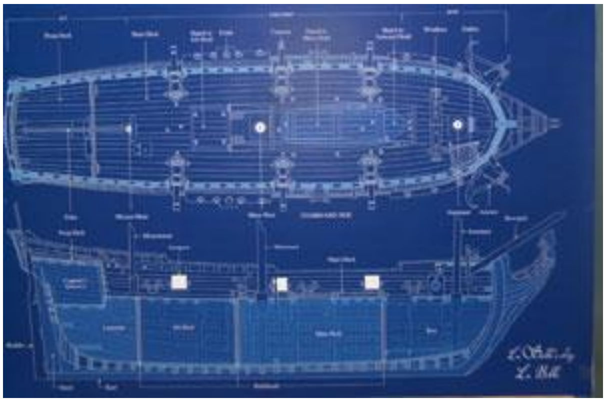
4. Avoid trick, or catch items that are so phrased that the correct answer depends on a single obscure key word.to which even good students are unlikely to give sufficient expression.

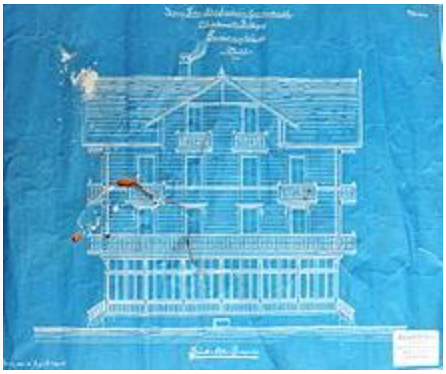
5. Avoid items which contain irrelevant clues.

6. Avoid items which furnish the answers to other items.

7. All the pupils are to take the same tests and permit no chance among items. Pupils cannot be compared with one another unless they all take the same tests.

Blueprint of the French galleon *La Belle*





Architectural drawing, 1902

Architectural drawing, Canada, 1936

A **blueprint** is a reproduction of a technical drawing, an architectural plan, or an engineering design, using a contact print process on light-sensitive sheets. Introduced by Sir John Herschel in 1842 the process allowed rapid, and accurate, production of an unlimited number of copies. It was widely used for over a century for the reproduction of specification drawings used in construction and industry. The blueprint process was characterized by white lines on a blue background, a negative of the original. The process was not able to reproduce color or shades of grey.

The term *blueprint* is also used less formally to refer to any floor plan (and even less formally, any type of plan).

The blueprint process

The blueprint process is based on a photosensitive ferric compound. The best known is a process using ammonium ferric citrate and potassium ferricyanide. The paper is impregnated with a solution of ammonium ferric citrate and dried. When the paper is illuminated, a photoreaction turns the trivalent ferric iron into divalent ferrous iron. The image is then developed using a solution of potassium ferricyanide forming insoluble ferroferricyanide (Prussian blue or Turnbell's blue) with the divalent iron. Excess ammonium ferric citrate and potassium ferricyanide are then washed away. The process is also known as cyanotype.

This is a simple process for the reproduction of any light transmitting document. Engineers and architects drew their designs on cartridge paper; these were then traced on to tracing paper using India ink for reproduction whenever needed. The tracing paper drawing is placed on top of the sensitized paper, and both are clamped under glass, in a daylight exposure frame, which is similar to a picture frame. The frame is put out into daylight, requiring a minute or two under a bright sun, or about ten minutes under an overcast sky to complete the exposure. Where ultra-violet light is transmitted through the tracing paper, the light sensitive coating converts to a stable blue or black dye. Where the India ink blocks the ultra-violet light, the coating does not convert and remains soluble. The image can be seen forming. When a strong image is seen the frame is brought indoors to stop the process. The unconverted coating is washed away, and the paper is then dried. The result is a copy of the original image with the clear background area rendered dark blue and the image reproduced as a white line.

This process has several features

- the image is stable
- as it is a contact process, no large-field optical system is required
- the reproduced document will have the same scale as the original
- the paper is soaked in liquid during processing, and minor distortions can occur

- the dark blue background makes it difficult to alter preserving
- the approved drawing during use
- a record of the approved specifications
- the history of alterations recorded on the sheet
- the references to other drawings

Introduction of the blueprint process eliminated the expense of photolithographic reproduction or of hand-tracing of original drawings. By the later 1890s in American architectural offices, a blueprint was one-tenth the cost of a hand-traced reproduction. The blueprint process is still used for special artistic and photographic effects, on paper and fabrics

Targeting **Objectivity**, Reliability, and Validity. A **test** that is objective measures without reference to outside influences. For example, an objective **test** of personality will return the same answers regardless of whether the person completing the **test** uses a pen or pencil

Computer-aided assessment (or "**computer-assisted assessment**") is a term that covers all forms of assessments, whether summative (i.e. tests that will contribute to formal qualifications) or formative (i.e. tests that promote learning but are not part of a course's marking), delivered with the help of computers. This covers both assessments delivered on computer, either online or on a local network, and those that are marked with the aid of computers, such as those using Optical Mark Reading (OMR). There are number of open source online tools to handle exams conducted on OMR sheets.

Computer-aided assessment can be viewed in a few different ways. Technically, assignments that are written on a computer and researched online are computer-aided assessments. One of the most common forms of computer-aided assessment (in terms of e-learning) is online quizzes or exams. These can be implemented online, and also marked by the computer by putting the answers in. Many content management systems will have easy to set up and use systems for online exams.

Online examination

Conducting a test online to measure the knowledge of the participants on a given topic. In the olden days everybody had to gather in a classroom at the same time to take an exam. With online examination students can do the exam online, in their own time and with their own device, regardless where they life. You online need a browser and internet connection.

Advantages of an online examination

An online examination system has plenty of advantages:

1. **It saves paper.**
   You never have to print an exam for your students and hand them out. Saves paper. Saves trees. Everybody happy.
2. **It saves time.**
   You can setup an exam in such a way that it will auto-grade itself. If you only use multiple choice questions you never have to check an exam again. The online exam system will take care of that hassle. Completely automated.
3. **It saves more time.**
   The distribution of the exam doesn't take you any time. Just upload the email addresses of your students and send them an invite. And after the exam they get their result instantly.
4. **It saves you money.**
   You don't need to buy any paper. Sending an email is free. On top of that you save on the logistics: your students don't have to assemble in classroom to take the exam. They can do it within a given time frame from their own device. You don't have to rent a classroom. You don't have to hire someone to check the students taking the exam.
5. **It saves the student money.**
   Students don't have to travel to a specific location to conduct the exam. So even for students from remote area's it's possible to take the exam.
6. **It's more secure.**
   You can make a big question bank with a lot of questions. Every student gets a random selection from that question bank. So it's of little use to share the questions among the exam takers to give them a head start. Try that on paper ;)

Disadvantages of an online examination

And now for the disadvantages:

1. You have to keep in mind that your students will take the exam on their own device in their own time with nobody to check up on them, so you have to alter your questions to provide for this situation. You have to ask questions which are not easily to be retrieved from books

or the internet. Or you can add a timer to each question so there is no time to search for the answer.

2. Open text questions are possible, but they don't auto-grade, so you have to check them yourself.
3. An online exam system is a little bit more susceptible for fraud. So you have to keep that in mind if you setup your exam. Do you want to share the results immediately after the result? In that case you can setup a question bank to solve the issue of fraud. Handing out all questions & Answers of a question bank to students is ok. Because they have to learn all the questions & answers by heart. And when they're done they master the material.

Now you know what the advantages and disadvantages are of an online examination, you may want to read more about the difference between a test and an examination.

Measures of Central Tendency

In statistics, a central tendency (or measure of central tendency) is a central or typical value for a probability distribution. It may also be called a center or location of the distribution. The most common measures of central tendency are the arithmetic mean, the median and the mode.

Measures

The following may be applied to one-dimensional data. Depending on the circumstances, it may be appropriate to transform the data before calculating a central tendency. Examples are squaring the values or taking logarithms. Whether a transformation is appropriate and what it should be, depend heavily on the data being analyzed.

Arithmetic mean or simply, **mean**

the sum of all measurements divided by the number of observations in the data set.

Median

the middle value that separates the higher half from the lower half of the data set. The median and the mode are the only measures of central tendency that can be used for ordinal data, in which values are ranked relative to each other but are not measured absolutely.

Mode

the most frequent value in the data set. This is the only central tendency measure that can be used with nominal data, which have purely qualitative category assignments.

Geometric mean

the *n*th root of the product of the data values, where there are *n* of these. This measure is valid only for data that are measured absolutely on a strictly positive scale.

Harmonic mean

the reciprocal of the arithmetic mean of the reciprocals of the data values. This measure too is valid only for data that are measured absolutely on a strictly positive scale.

Weighted arithmetic mean

an arithmetic mean that incorporates weighting to certain data elements.

Interquartile mean

a truncated mean based on data within the interquartile range.

Midrange

the arithmetic mean of the maximum and minimum values of a data set.

Geometric median

which minimizes the sum of distances to the data points. This is the same as the median when applied to one-dimensional data, but it is not the same as taking the median of each dimension independently. It is not invariant to different rescaling of the different dimensions.

Quadratic mean (often known as the root mean square)

useful in engineering, but not often used in statistics. This is because it is not a good indicator of the center of the distribution when the distribution includes negative values.

The **standard deviation** (**SD**, also represented by the Greek letter sigma **σ** or the Latin letter s) is a measure that is used to quantify the amount of variation or dispersion of a set of data values.[1] A low standard deviation indicates that the data points tend to be close to the mean (also called the expected value) of the set, while a high standard deviation indicates that the data points are spread out over a wider range of values

Standard Deviation

The Standard Deviation is a measure of how spread out numbers are.

Its symbol is **σ** (the greek letter sigma)

The formula is easy: it is the **square root** of the **Variance.** So now you ask, "What is the Variance?"

Variance

The Variance is defined as:

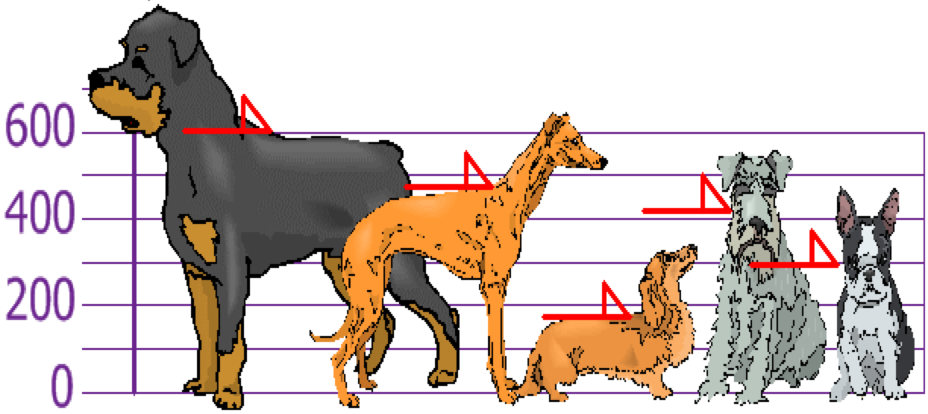
The average of the **squared** differences from the Mean.

To calculate the variance follow these steps:

- Work out the Mean (the simple average of the numbers)
- Then for each number: subtract the Mean and square the result (the *squared difference*).
- Then work out the average of those squared differences. (Why Square?)

Example

You and your friends have just measured the heights of your dogs (in millimetres):



The heights (at the shoulders) are: 600mm, 470mm, 170mm, 430mm and 300mm.

Find out the Mean, the Variance, and the Standard Deviation.

Your first step is to find the Mean:

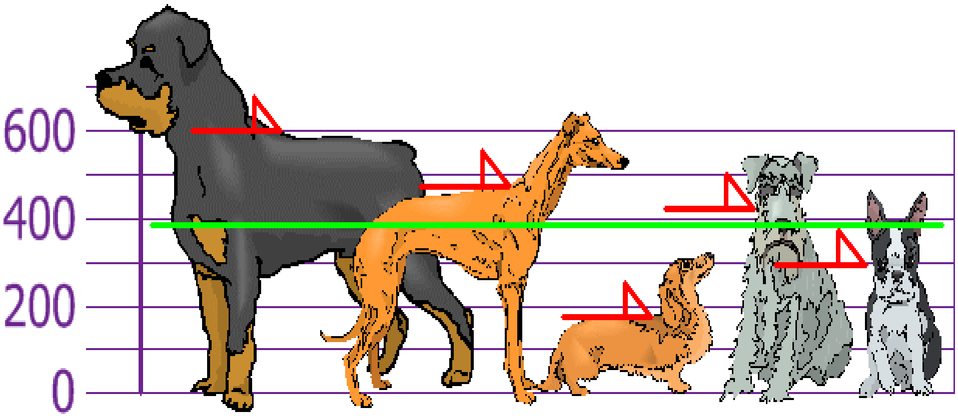
Answer:

Mean = *600 + 470 + 170 + 430 + 3005*

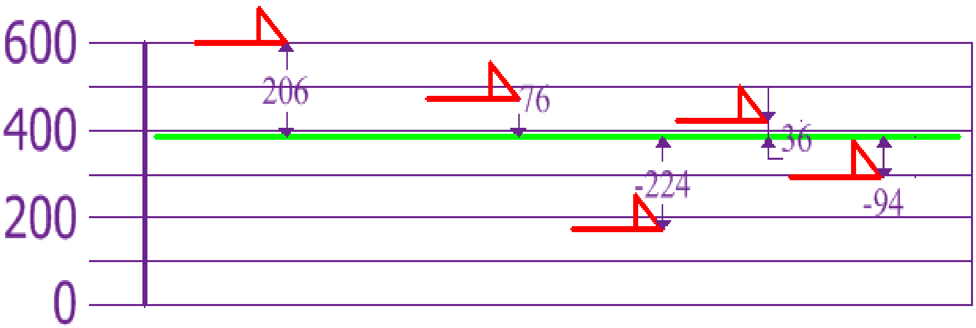
= *19705*

= 394

so the mean (average) height is 394 mm. Let's plot this on the chart:



Now we calculate each dog's difference from the Mean:



To calculate the Variance, take each difference, square it, and then average the result:

Variance

σ^2 = $206^2 + 76^2 + (-224)^2 + 36^2 + (-94)^2$**5**

= $42436 + 5776 + 50176 + 1296 + 8836$**5**

= 108520**5**

= 21704

So the Variance is **21,704**

And the Standard Deviation is just the square root of Variance, so:

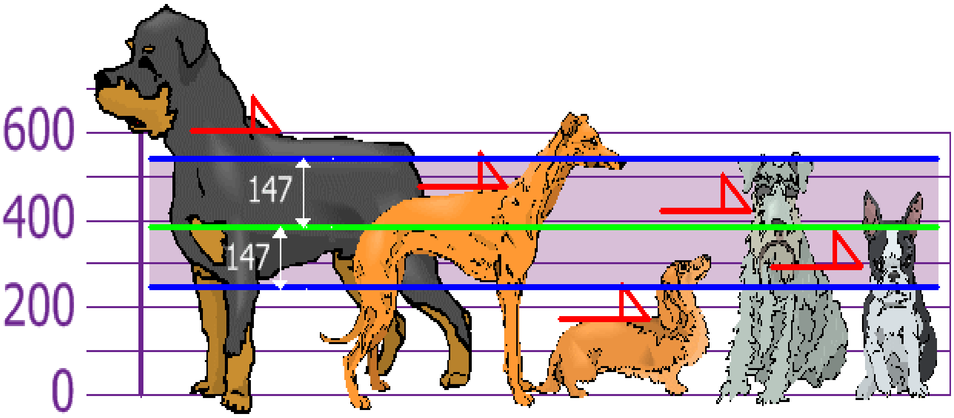
Standard Deviation

σ = $\sqrt{21704}$

= 147.32...

= **147** *(to the nearest mm)*

And the good thing about the Standard Deviation is that it is useful. Now we can show which heights are within one Standard Deviation (147mm) of the Mean:



So, using the Standard Deviation we have a "standard" way of knowing what is normal, and what is extra large or extra small**.**

The **quartile deviation** is a slightly better measure of absolute dispersion than the range, but it ignores the observations on the tails. If we take difference samples from a population and calculate their **quartile deviations**, their values are quite likely to be sufficiently different.

As the SIR is half of the Interquartile Range, all you need to do is find the IQR and then **divide** your answer by 2. Another way is to use the quartile deviation formula: Note: You might see the formula **QD** = $1/2(Q_3 – Q_1)$. Algebraically they are the **same**.

How to Calculate the Quartile Deviation for Group Data - Definition and Example

Definition:

Quartile Deviation (QD) means the semi variation between the upper quartiles (Q3) and lower quartiles (Q1) in a distribution. Q3 - Q1 is referred as the interquartile range.

Formula:

QD = Q3 - Q1/ 2

Example:

Calculate the QD for a group of data, 241,521,421,250,300,365,840,958.

Solution:

Given data = { 241,521,421,250,300,365,840,958 }

Step 1:

First, arrange the given digits in ascending order = 241,250,300,365,421,521,840,958. Total number of given data (n) = 8.

Step 2:

Calculate the center value (n/2) for the given data {241,250,300,365,421,521,840,958}. n=8

n/2 = 8/2

n/2 = 4. From the given data, { 241,250,300,**365**,421,521,840,958 } the fourth value is 365

Step 3:

Now, find out the n/2+1 value. i.e n/2 +1 = 4+1=5 From the given data, { 241,250,300,365,**421**,521,840,958 } the fifth value is 421

Step 4:

From the given group of data, { 241,250,300,365,421,521,840,958 } Consider, First four values Q1 = 241,250,300,365 Last four values Q3 = 421,521,840,958

Step 5:

Now, let us find the median value for Q1. Q1= {241,250,300,365} For Q1, total count (n) = 4 Q1(n/2) = Q1(4/2) = Q1(2) i.e) Second value in Q1 is 250 Q1((n/2)+1) = Q1((4/2)+1) = Q1(2+1) = Q1(3) i.e) Third value in Q1 is 300 Median (Q1) = (Q1(n/2) + Q1((n/2)+1)) / 2 (Q1) = 250+300/2 (Q1) = 550/2 = 275

Step 6:

Let us now calculate the median value for Q3. Q3= {421,521,840,958} For Q3, total count (n) = 4 Q3(n/2) = Q3(4/2) = Q3(2) i.e) Second value in Q3 is 521 Q3((n/2)+1) = Q3((4/2)+1) = Q3(2+1) = Q3(3) i.e) Third value in Q3 is 840. Median (Q3) = (Q1(n/2) + Q1((n/2)+1)) / 2 (Q3) = (521 + 840) / 2 (Q3) = 1361/2 = 680.5

Step 7:

Now, find the median value between Q3 and Q1. Quartile Deviation = Q3-Q1/2 = 680.5 - 275/2 = 202.75

Rank Correlation

When someone refers to the correlation between two variables, they are probably referring to the Pearson correlation, which is the standard statistic that is taught in elementary statistics courses. Elementary courses do not usually mention that there are other measures of correlation.

Why would anyone want a different estimate of correlation? Well, the Pearson correlation, which is also known as the product-moment correlation, uses empirical moments of the data (means and standard deviations) to estimate the linear association between two variables. However, means and standard deviations can be unduly influenced by outliers in the data, so the Pearson correlation is not a robust statistic.

A simple robust alternative to the Pearson correlation is called the Spearman *rank correlation*, which is defined as the Pearson correlation of the *ranks* of each variable. (If a variable contains tied values, replace those values by their average rank.) The Spearman rank correlation is simple to compute and conceptually easy to understand. Some advantages of the rank correlation are

- The rank correlation is always in the interval [-1, 1]. For "tame" data, the Spearman and Pearson correlations are close to each other. In fact, if X and Y are bivariate normal random variables with Pearson correlation ρ, then the Spearman correlation is 6/π arcsin(ρ/2), which is *very* close to the identity function on [-1, 1].

- The rank correlation is robust to outliers. For example, the data set X= {1, 2, 2, 5} has the same ranks as the set Y= {1, 2, 2, 500}. Therefore, for any third variable Z, the rank correlation between X and Z is the same as the rank correlation between Y and Z.

- The rank correlation is invariant under any monotonic increasing transformation of the data, such as LOG, EXP, and SQRT. In the previous example, the rank correlation between Z and X is the same as the rank correlation between Z and the log-transform of X, which is {log (1), log (2), log (2), log (5)}. This is in contrast to the Pearson correlation, which is only invariant under affine transformations with positive scaling factors (X → a*X + b, where a > 0).

- The rank correlation can be used for any ordinal variable. For example, if the variable X has the ordinal values {"Very Unsatisfied", "Unsatisfied", "Satisfied", "Very Satisfied"}, and the variable Y has the ordinal values {"Low", "Medium", "High"}, then you can compute a rank correlation between X and Y.

Pearson Correlation Coefficients, N = 19			
	Height	Weight	Age
Height	1.00000	0.87779	0.81143
Weight	0.87779	1.00000	0.74089
Age	0.81143	0.74089	1.00000

Spearman Correlation Coefficients, N = 19			
	Height	Weight	Age
Height	1.00000	0.85576	0.76906
Weight	0.85576	1.00000	0.72536
Age	0.76906	0.72536	1.00000

According to both statistics, these variables are very positively correlated, with correlations in the range [0.7, 0.88]. Notice that the rank correlations (the lower table) are similar to the Pearson correlations for these data. However, if the data contain outliers, the rank correlation estimate is less influenced by the magnitude of the outliers.