Instructional Design for Multimedia

As a teacher or a trainer, you must have taught, conducted or attended a number of classes or training sessions. You would have noticed that some classes were well planned and some others were not so. This happens not only in face-to-face instructional situations but also in educational audio, video or computer programmes. It may also happen in the instructional print materials like self-learning material, textbooks, handouts etc. The effectiveness of any instructional programme or instructional material depends upon an appropriate planning or designing, what is called in professional parlance, "Instructional Design".

Instructional Design is relatively a young discipline. If we unravel the meaning of the term, it is made up of two words, *Instruction* and *Design*. In its literal meaning, **Instruction** means a set of events that facilitate learning. The word **Design** is a generic term, which means "a creative pattern". These days we read about Designer watches, Designer clothes, etc. This means that the watch or the dress is specially designed, hence unique. To make an item unique through the process of designing, we use knowledge, observation and creativity. The purpose of designing instruction is to plan and create situations that enhance learning opportunities of the individuals. This means that the instruction has to be planned if it is to be effective and designed in some systematic way. This section for example, has been designed to facilitate your learning about the meaning, theories, models and application of instructional design for multimedia.

Objectives

At the end of the section, you will be able to
- Define Instructional Design
- Explain the basis of Learning Theories in Instructional Design
- Describe a few models of Instructional Design
- State Instructional Design for Multimedia.

Instructional Design - Concepts

There are several words and phraseologies associated with the word 'Instruction'. Most common ones are **Instructional Science**, **Instructional Technology** and **Instructional Design**. According to Mukopadhyay (2001) 'Instructional Science provides the theoretical construct to the process of instruction'. 'Instructional Technology is the applied aspect of Instructional Science based on Instructional Design'.

The meaning of Instructional Design is indicated by the word 'Design' itself. Design has been claimed as a science by itself. (van Patten, 1989). In layman's language, 'Instructional Design means the plan of action with a purpose'. For our understanding in this section we will describe instructional design as a separate entity, which is separate from Instructional Science and Technology. Instructional Design is a discipline of study and has evolved over the last forty years as a science. It is a young profession deriving its inspiration and contents from areas of communication, psychology, media etc. to form its own theory. Various authors have

defined instructional design in their own way. Some of the definitions are given in the box below:

> Instructional Design simply means using a systematic process to understand a human performance problem, figuring out what to do about it and then doing something about it (McArdle, 1991).
>
> Instructional Design is the science of creating detailed specifications for the development, evaluation and maintenance of situations which facilitate the learning (Richey, 1986).
>
> Instructional Design is the entire process of analysis of learning needs and goals and the development of a delivery system to meet the needs (Briggs, 1977).

In simple words, instructional design is a pedagogic or teaching device that makes instruction as well as the instructional material more engaging, effective and efficient. The statement "whereas physicians engineer health, architects engineer space, instructional designers engineer human performance" (van Patten, 1989) focuses on the importance of instructional design.

Learning Theories and Instructional Design

Learning theories have significant bearing on instructional design, as there is a logical development from learning to instruction. Instructional design optimizes learning outcomes while learning theories are the backbone of any instructional design. Instructional design is the articulation or the manifestation of the learning theories, and its main aim is to optimize learning by using the known theories of learning.

Strain (1994) states that a wide divergence of views exists among the researchers in instructional design regarding the relative contribution of various schools of psychology and claims that instructional design has grown out of the systems approach with its roots firmly in behaviorists psychology that has dominated instructional design since the 1960s. However, Hannafin and Reiber (1989) point out that instructional design developed in the 1980s by Gagne, Merrill, Reigeluth and Scandura is largely due to the influence of cognitive theories of learning. Of course the emphasis has been on how information is retrieved, selected, processed and perceived. More recent developments are due to Constructivist learning theories. Instructional designers no longer depend on any one theory. They draw upon and incorporate from different learning theories, mix those with other information and apply the results to meet human needs (van Patten, 1989).

Let us examine the three basic schools of theories of learning, namely, Behaviorism,

Cognitivism and Constructivism. These three schools of learning theories have implications for instructional design. A brief introduction to the three learning theories is given in the table-1.

In short, behaviorists believe that learning results in changing the learning behaviour whereas cognitivists believe that learning occurs when learners add new concepts and ideas to their cognitive structure. Constructivists believe that the learners construct knowledge for themselves -- each learner individually. All the three learning theories have implications for instructional design.

Table -1: Descriptions of various learning theories

Theory	Psychologists	Descriptions
Behaviourism	✔ John B. Watson ✔ Ivan Pavlov ✔ E. L. Thorndike ✔ B. F. Skinner	• Behavioural researches have been conducted on animals but are related to human behaviour. • Based on observable changes in behaviour which can be measured. • Learning results from the classical conditioning of simple reflexes. • Learning is the formation of a connection between stimulus and response.
Cognitivism	✔ Jean Piaget ✔ Lev Vygotsky ✔ Bruer Jerome ✔ David Ausubel	• Cognitive Psychologists studied human behaviour. • Theory is based on the thought process behind the behaviour. • Learning involves associations established through contiguity and repetition. • Stressed on the role of reinforcement which provides feed back about the correctness of responses. • Learning involves subsuming new material to existing cognitive structure.
Constructivism	✔ George Herbert Mead ✔ D. H. Jonassen ✔ D.N. Perkins	• Learners construct their own perspective of the world, through individual experiences and schema. • Learners construct their own knowledge. Learners are encouraged to search for other related relevant information. • Prepare the learner to problem solving ambiguous situations.

Learning Theories and their Implications for Instructional Design

Behaviourists emphasize changes in behaviour as the outcome of learning. Behaviourist principle of reinforcement, retention and transfer of learning are important design considerations, as learning is facilitated by reinforcing the correct performances. Statements of behavioural objectives allow the learners to know specifically when they have achieved their objectives. In this way, learners can monitor their own progress. The knowledge of objectives serves as a reinforcing agent. The frequency of reinforcement is also a design issue. Presenting the content of the instruction in smaller steps, followed by testing and reinforcing performance immediately, does this. Retention of the information for the learners is also important for the instructional designer. Materials that provide more reinforcing activities help in the retention of what has been learnt.

Cognitive psychologists like Piaget, Bruner and Ausubel contend that learning is an internal process that cannot be observed directly. Learners first remember and then retrieve information from the memory. Cognitivists emphasize on how the human mind works. They put particular emphasis on memory. The implication of this theory for the instructional designers is that they could use various techniques like chunking, mnemonics and meaningful organization of content and give practice for storing and retrieving information. Practice implies provision of increased opportunities to the learners for reward and reinforcement. Cognitive structures are created through practice, which leads to an efficient use of long-term memory. For example, instructional designers include pictures used in video programmes or practice exercises in the self-learning material that offer opportunities for practice. Practice is important in learning cognitive tasks as well as motor skills.

Constructivists promote an open ended learning experience where methods and results of learning are not easily measured and are different for each learner. The implication of constructivism for the instructional designer is that the learners should attach themselves to the content domains. Constructivists believe that learning occurs when it is situated, contextual, problem based, social and authentic.

Learning theories influence Instructional Design in a significant way. Learning theory becomes an essential element in the preparation of instructional design professionals because they permeate all dimensions of instructional design (Schiffman, 1991). There is no one single theory which designers keep in mind while designing the instructional strategies and content. Ertmer and Newby (1993) feel that the

- behavioural approach can effectively facilitate mastery of the content,

- cognitive strategies are useful in teaching problem solving tactics, and

- constructivist strategies are suited for dealing with ill defined problems.

Instructional Design: Theory and Models

Let us examine a few instructional design theories and models. Before we do so, let us see the difference between a theory and a model.

A *theory* provides a general explanation for observations and explains the behaviour whereas a *model* is a mental picture that helps us to understand something that we cannot see or experience directly (Dorin, Demmin and Gabel, 1990).

There are various instructional design theories and models developed by various authors. Let us explore what is an instructional design theory. Reigeluth (1999) defines an instructional design theory as the one "that offers explicit guidance on how to better help people learn and develop". The kinds of learning may include cognitive, emotional, social, physical and spiritual learning.

Reigeluth (1999) states four major characteristics that all instruction design theories have in common. These are:

- Design orientation,

- Identification of *methods* of instruction and situations,

- Methods of instruction that can be broken into more *detailed component methods,* and

- Choice of *Probabilistic* Methods.

The design theories have become important as they help the stakeholders to develop a vision of the instruction early in the design process (Diamond, 1980). This vision is in terms of ends (how learners will be different as a result of it) and the means (how those changes in the learners will be fostered). Banathy (1991) states that instructional design theories should allow for much greater use of the notion of "user-designer". This means that the users play a major role in designing their own instruction.

These theories are also important as they provide guidance at three levels (Reigeluth, 1999). These are:

- methods that best facilitate learning under different situations,

- learning tool features that best allow an array of alternative methods to be made available to learners,

available to learners,

- system features that best allow an instructional design team to design quality-learning tools.

In table-2 different models of instructional design are summarized with their features.

All these models are suitable for the design of instruction of course units (in print, multimedia and online) and have the following components in common:

- Identify and analyze the instructional objectives,
- Plan and design solutions to the instructional objectives,
- Implement the solutions, and
- Evaluate and revise objectives, strategies, etc.
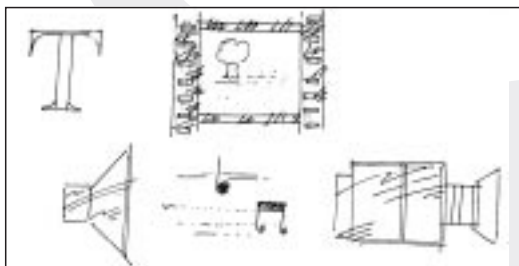
Multimedia

Media is a Latin word and is used to describe ways to convey messages and information. When we talk about media we think of newspapers, magazines, radio, TV, audio- video programmes, computers, etc. Many prefixes are used with the word Media like *Multimedia*, *Electronic media*, *Interactive media*, etc. The most common buzzword used in education is Multimedia, which is the integration of text, audio, video, graphics and animation into a single medium. Instructional multimedia is the integration of various forms of media in the instructional process. It is the technology that combines print, radio, television, animation, photographs, and other forms of illustration. Integration of different media multiplies the impact of a message. The focus is on instruction and learning. According to the research reports by Mayer and McCarthy (1995) and Walton (1993) 'multimedia has gained acceptance with many benefits derived from its use. Learning gains are 56% greater, consistency of learning is 50-60% better and content retention is 25-50% higher'. Instructional multimedia focuses on what the learner is expected to do upon the complexion of the instruction.

On the one hand, research on multimedia has established learning gains of significant order over the conventional instructional strategies, and on the other, has shown how instructional design is a tested, well-researched mechanism of enhancing human learning. By logical extrapolation, we can say that instructional multimedia can be more effective, if it is backed up by scientific instructional design.

Table- 2: Models of instructional design

Models of Instructional Design	Description
Gagne-Briggs Model	To design instruction • Categorize learning outcomes • Organize instructional events for each kind of learning outcome • There are nine instructional events • Events are tailored to the kind of outcome to be achieved • Model is adapted to Web Based Instruction
David Merrill	The model by David Merrill (Component Display Theory) is based on the following assumptions • Different classes of learning outcomes require different procedures for teaching and assessment • Teaches individual concepts • Classifies objectives on two dimensions • Formats instruction to provide student directed teaching
Dick and Carey	This model • Uses a systems approach for designing instruction • Identifies instructional goals in the beginning and ends up with summative evaluation • Is applicable for K-12 to business to government
Hannafin and Peck	The Model has three phases • Need assessment is performed in the first phase • Second is the design phase • Instruction is developed and implemented in the last phase All the phases involve a process of evaluation and revision
Gerlach and Ely	The Model • Includes strategies for selecting and including media within instruction • Is suited to higher education

Instructional Design for Media

Media has become an integral part of education. There are two major forms of media-radio and television (mass media) and audio and video (modular media). The radio and television as media depends upon the audio and video programmes. Hence, from the software angle, we can examine the modular media, though their implications for instructional design will be widely different when we integrate inflexible mass media like radio and television or flexible audio and video programmes in designing our multimedia instructional system. To avoid complexity and also to allow space for creativity of the teacher in designing instruction through multimedia, we will focus on instructional design of modular media, namely the audio and video programmes. There are, however, several formats and status within the overall scheme of instruction. Let us examine some of the possibilities (Table-3).

Thus as shown in table-3, there are at least 12 alternative possibilities. Instructional design is spread among the 12 possibilities in the matrix. The Integrated and Reinforcing programs are part of the multi-channel learning system (MCLS) context.

Conventionally, instructional design components are: objectives, content (content analysis and level validation), transactional methods (lecture, video, audio, etc. or in combination) and evaluation (interim and end of learning). In self-learning print materials all these are explicit. In audio/video that is not usually true, though both objectives and evaluation can be built into the programme, in the script and at the production stage.

The audio/video programmes are close to linear Programmed Learning Material (PLM). An examination of raw scripts would indicate that these are developed frame by frame, except for the end-of-frame questions and answers, as is common with PLM. In the conventional audio/video format, there is no way of skipping frames except through fast-forward. In videodisc or CD-ROM, there is random access facility and one can skip frames.

Figure 1 illustrates the instructional design process in audio and video media. The instructional design of media largely depends upon two components, namely, the content, duly analyzed and sequenced and choice of media format. Objectives and assessment can back up the media effectiveness.

The design presented above is for non-interactive audio and video programmes. With suitable modification, it is possible to use the design for creating interactive video and audio.

Table - 3: Media format and status in Instruction

Format ➡ Status ⬇	Lecture or Illustrated Lecture --Audio main focus	Documentary -- visual main focus audio second fiddle narrative	Docu-drama -- Combination of documentary & drama formats drama brought into for illustration documentary the main stay	Drama -- Best combination of audio & video most powerful communication in affective domain
Integrated -- media is part and parcel of the instructional material where print material refers to media back and forth.	01	02	03	04
Stand Alone -- media programmes is self-contained and replaces print material or works as alternative.	05	06	07	08
Complementary or Reinforcing-- neither integrated nor stand-alone, media enriches learning through print mode.	09	10	11	12

Note: Numbers entered into the cells indicate various alternative possibilities

Instructional Design for Multimedia

We have discussed so far how multimedia is a single, integrated medium that consists of media like text, audio, video, graphics, animation, etc. The major challenge in designing instruction through multimedia is, therefore, the *choice of media* and their *application* for optimizing human learning with reference to the stated instructional objectives. We must, hence, consider the various components that constitute the instructional design for multimedia learning system such as objectives, content, media options, and evaluation options.

Objectives: the first challenge is to specify the objectives of the multimedia learning. The objectives must be stated in behavioural and measurable terms. They can range from simple to complex, from lower to higher order learning. The objectives may belong to the domains of cognition, psychomotor and affection.

Content: the content of any instructional design is necessarily informed by stated objectives of learning. Depending upon the objectives the content will also range
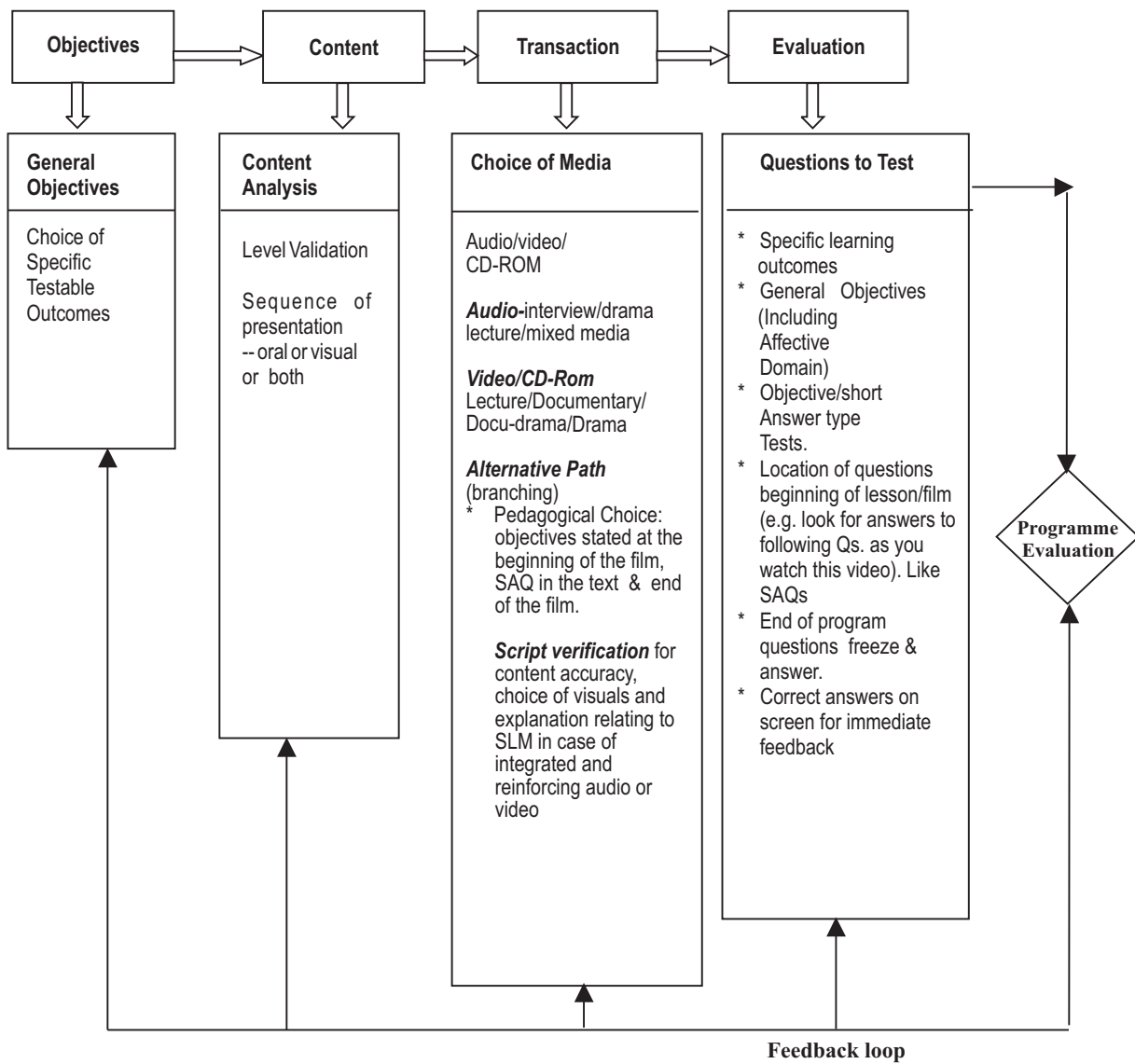
Objectives	Content	Transaction	Evaluation

General Objectives

Choice of Specific Testable Outcomes

Content Analysis

Level Validation

Sequence of presentation -- oral or visual or both

Choice of Media

Audio/video/ CD-ROM

*Audio-*interview/drama lecture/mixed media

Video/CD-Rom Lecture/Documentary/ Docu-drama/Drama

Alternative Path (branching)
* Pedagogical Choice: objectives stated at the beginning of the film, SAQ in the text & end of the film.

  Script verification for content accuracy, choice of visuals and explanation relating to SLM in case of integrated and reinforcing audio or video

Questions to Test

* Specific learning outcomes
* General Objectives (Including Affective Domain)
* Objective/short Answer type Tests.
* Location of questions beginning of lesson/film (e.g. look for answers to following Qs. as you watch this video). Like SAQs
* End of program questions freeze & answer.
* Correct answers on screen for immediate feedback

Programme Evaluation

Feedback loop

Fig.1: Instructional Design in Audio and Video Programmes

from simple to high level of complexity. The choice of content must also ensure that there is adequate and correct provision for the achievement of objectives.

Media Options: as mentioned above multimedia essentially incorporates several media like text (as in printed text), audio, video, graphics, animation etc. It is important to match the learning objectives and decide the media to synchronize the design and learning from it. Each media can offer either the whole or part of the content with or without referring to one another. For example, dissection of a frog can be shown through animation and also through a video programme. But as multimedia offers interactivity, learners can actually feel the dissection if it is animated and the multimedia programme runs like an actual dissection. Similarly, for language learning through multimedia, audio is very important.

Evaluation Options: evaluation is part of instructional design. Without evaluation, one would rarely, if ever, understand the achievement of objectives, which is the primary goal of instructional design. Evaluation options must include both summative and formative evaluation. However, in both the cases of formative and summative evaluation, we can choose from online, offline, paper and pencil versus performance tests, etc.

In this section, we have dealt initially with fundamental issues of learning theories, and concept, theory and models of instructional design. We then have followed it up with our conceptualization of educational multimedia. In the final section, our challenge was to build up the synthesis of our learning in designing instruction for multimedia.

The challenge is in the synthesis of the three dimensions of media option and content with reference to the learning objectives. Depending upon the purpose and actual application of the multimedia instructional system, this design can be used for designing teacher as well as the learner-guided designs. The learner-guided designs (Banathy, 1991; Mukhopadhyay, 2001) can lead to differentiate instructional design that suits individual learner.

Finally, instructional design for multimedia learning system must be a document indicating the stated goals, choice of content with specifications of levels of difficulties, the choice of instructional methods and media, and strategies of evaluation. The documented design must incorporate instructional design of the micro components of the multimedia learning system as well.

In the next section we will discuss the process of scriptwriting for multimedia.