Indira Gandhi National Open University
Staff Training and Research Institute of
Distance Education

Block

2

INSTRUCTIONAL DESIGN: THEORIES AND MODELS

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Indira Gandhi National Open University
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Distance Education

MDE-412
Instructional Design

Block

2

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BLOCK INTRODUCTION

Dear Learner,

We welcome you to Block-2: Instructional Design: Theories and Models consisting of six units (Unit-5 to Unit-10).

By now, you must have understood the concept of learning, the basics of instruction, and the relationship between learning and instruction discussed in Unit-1 of Block-1. You also must have become conversant with the three Schools of Thought, i.e., Behaviouristic, Cognitivist and Constructivist theories of learning described and discussed in Units 2, 3 and 4 of Block-1.

This Block 2 is an overview of instructional design specially prepared to acquaint you with different theories and models of instructional design with their implications for designing instruction in open and distance education.

Unit-5 describes the concept of instructional design (ID), purposes of ID, tasks involved in the process of ID, roles and responsibilities of an instructional designer, and discusses different theories and models of ID. These are: R.M. Gagne's nine events of instruction, Banathy's design of instructional systems, Keller's motivational design of instruction, Dick and Carey model, Bergman and Moore model, Smith and Ragan model, Assure model and Constructivist instructional design models.

In Unit-6, we present M. David Merrill's Component Display Theory (CDT). This theory of insrtuction deals with the components for presenting content with specific objectives and instructional sequences. In this unit, the new version of CDT, i.e., A Pebble-in-Pond approach has been discussed based on course structures and instructional transactions with the help of illustrations.

In Unit-7, we have discussed Elaboration theory (ET) of instruction by Charles M. Reigeluth and Faith S. Stein. This theory explains the scope and sequence decisions for relatively large chunks of instruction. It guides an instructional designer/teacher/ course developers to take decisions about when to sequence the instructional events to make a difference, as well as when to use alternative methods for sequencing instruction.

Unit-8 pertaining to Cognitive Load theory (CLT) and Cognitive Flexibility theory (CFT) describes some of the basic principles of cognitive load theory and cognitive flexibility theory. Cognitive strategies: rehearsal, elaboration, organizing, and mentoring to students are discussed in this unit.

Unit-9 Theory of Multiple Intelligences provided by Howard Gardner delineating the eight types of intelligences of human beings, which vary from person to person. In this unit, we have presented you different illustrations, which can help you to design instruction that capitalize upon each of the eight intelligences.

In Unit-10, we have discussed the Four Component Instructional Design (4C/ID) Model provided by J.J. G.van Merrienboer and P.A. Krischner. This unit describes the mechanisms to design instruction in complex learning integrating higher order skills.

To summarize, these theories and models of instructional design (ID) are used for translating the principles of learning and instruction into frameworks or blueprints for designing instructional materials in open and distance education. This block includes some of the selected theories and models that are widely used, and serve as foundations for designing instruction to inculcate in you some of the specialized skills required for designing the instructional materials with the help of selected theories and ID models.

Good luck!

Basanti Pradhan & Anita Priyadarshini

UNIT 5 INSTRUCTIONAL DESIGN: AN OVERVIEW

Structure

5.1 INTRODUCTION

We welcome you to the first Unit of the second Block of this course on Instructional Design (ID). Do you know what is Instructional Design (ID)? Are you aware of the various theories and models of Instructional Design (ID)?

In this unit, we will describe the concept of instructional design (ID) and we will also discuss the various theories and models for designing instruction. Instructional design as a process is the systematic development of instructional specification, i.e., the materials or output that contains the instructions, using the various theories of learning, ID models and communication technologies to provide quality instruction to distance learners. Instructional design theories and models pertain to how different learning events are designed, and what instructional strategies can be adopted for effective learning. It includes common tasks involved in most of the learning theories and models available to us. We have presented a few tasks involved in the process of ID so that you can select the appropriate tasks while designing instruction. In an early study by Andrews and Goodson (1980), about 40 different instructional design models were reported. While it is practically impossible to cover all the instructional design models available, we will discuss some selected theories and models that are widely used, and serve as a foundation for designing instruction for distance learners.

Adapted with permission from source: Course MES-056, Educational Technology, Block 2: Instructional Design. School of Education, IGNOU, New Delhi, pp. 69-88.

5.2 LEARNING OUTCOMES

After going through this unit, you should be able to:

- discuss the concept of instructional design;
- explain the importance of different tasks involved in instructional design process;
- describe different types of instructional theories of ID;
- apply the models of ID for designing instruction; and
- develop skills in designing instruction by using the theories and models of ID.

5.3 CONCEPT OF INSTRUCTIONAL DESIGN

Instructional design (ID) is a combination of two words 'instruction' and 'design'. But, what is instruction?

Instruction is "the deliberate arrangement of learning conditions to promote the attainment of some intended goal" (Driscoll, 1994, p. 332). According to Heinich (1999), "Instruction is the arrangement of information and environment to facilitate learning" (p.7), where environment covers the place of instruction, methods, media, equipment, etc., that guide a student's learning. In other words, instruction is goal-directed teaching, which has been more or less pre-planned. According to Gagne, et al. (1988), it is a human activity which facilitates learning. It involves a set of pre-planned activities that help in learning. Now, let us discuss what is design.

Basically design is about how to make things. Design is a creative process (Richey, 1986) and to design is to create a blue print and plan for something to execute, just like a house/building plan. In instructional design this process is almost similar to these tasks, where instructional designers/teachers plan and prepare a blueprint for instruction for the learning to happen.

According to Aggarwal (2007), a carefully prepared design can make a number of specific contributions. The benefits of preparing the design are:

- **The design focuses attention on goals**: Detailing the specifications is a first and foremost step in design. Clearly defined statement of goals helps to ensure that the goals are worthwhile and are clearly understood by the practitioners.
- **The design facilitates route to the action plan**: Planning the design provides the routes to action plan and the undesirable alternatives are eliminated before they are implemented.
- **Communication and coordination**: Design helps to make a sequential track of action plan and this, in turn, helps to give a boost to make good coordination of different type of activities.
- **The design prevents wastage of resources:** A clearly planned instruction reduces the load of unnecessary revision and thus helps to save student's time and cost of materials.

An instructional designer is required to look at different aspects of instructional materials, while preparing a blueprint for designing instruction. These are:

- Who (the learners; diversified and heterogeneous group);
- When (the sequence of events that should occur);
- How (the strategies, methods and media should be used); and
- What (instruments and strategies should be used for assessment).

- **What is Instructional Design?**

A number of other terms such as instructional development, instructional systems design, instructional design and development are used interchangeably to represent the term instructional design. According to Charles M. Reigeluth (1983), "Instructional design is concerned with understanding, improving and applying methods of instruction" (p. 7). According to Rita Richey (1986) , "Instructional design can be defined as the science of creating detailed specifications for the development, evaluation, and maintenance of situations, which facilitate the learning of both large and small units of the subject matter." This definition is similar to that of Briggs (1977), which describes an instructional design as "the entire process of analysis of learning needs and goals and the development of a delivery system to meet the needs" (p. xx). Briggs also indicates that design includes the "development of instructional materials and activities, and try out and revision of all instruction and learner assessment activities" (p. xx).

The result of instructional design is a blueprint that prescribes what methods of instruction should be used for what category or kind of distance learners, in what context and for what course. Thus, instructional design is a *process* that can be stated as a "systematic process of designing an instructional solution to an educational or training problem. It requires identifying causes of the problem, determining instructional objectives and recommending or outlining instructional materials" (Rogoff, 1987, p. 146).

From the above definitions and discussion, we can summarize that instructional design involves preparing a blueprint for design and development of instruction, utilizing the available multimedia and various multidisciplinary approaches for facilitating distance learning.

In the next section, we will discuss the various models available before us to follow in our own context. But, before that please do the following check your progress.

Check Your Progress 1

Note: i) Write your answers in the space given below.
ii) Check your answers with the answers given at the end of this Unit.

1) Define instructional design according to Charles M. Reigeluth?

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2) What are the main aspects to keep in mind while preparing a blue print for designing instruction?

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- **Purposes of Instructional Design**

The purposes of ID are:

1) To design instructional activities/events systematically (step-by-step) beginning with a basis of information to achieve identified objectives.

2) To cater to the needs of an individual distance learner.

3) Cost-effective use of Information and Communication Technology (ICT).
4) Effective use of pre-produced courses/programmes to facilitate individual learning.
5) To promote organised two-way communication between the distance learners and organisations.

- **Tasks involved in Instructional Design**

According to D.H. Andrews and L.A. Goodson *fourteen* common tasks in the instructional design process are:

1) Assessments of need, problem identification, occupational analysis, competence, or training requirements.
2) Consideration of alternative solutions to instruction.
3) Formulation of system and environmental descriptions and identification of constraints.
4) Formulation of goals and detailed sub-goals/learning outcomes/objectives in observable terms.
5) Development of pre-test and post-test matching goals and sub-goals.
6) Analysis of goals and sub-goals for types of skills/learning required.
7) Sequencing of goals and sub-goals/learning outcomes/objectives to facilitate learning.
8) Analysis of the learner population in terms of their age, grade level, entry behaviour, goals, etc.
9) Formulation of instructional strategy to match subject-matter and learner requirements.
10) Selection of media to implement strategies.
11) Development of courseware based on strategies.
12) Empirical testing of courseware with learner population, evaluation and revision.
13) Development of materials and procedures for installing, maintaining, and periodically repairing the instructional programme.
14) Costing instructional programmes.

Some of the tasks, which are carried out while designing instruction and preparing open and distance learning materials are: analysis of the content of the subject matter; identification of the learning attributes of the distance learners; designing a structure of the content; specification of the learning objectives/learning outcomes; selection of appropriate learning experiences in a planned sequence; designing of assessment strategies based on self-instruction; designing feedback components; and designing of the learner support services.

Instructional design is visualized both as an art and a science. Theories, models and research in ID provide a base to create learning materials. It is also dependent on the creativity of the instructional designer to create or design a blue print for a course or programme as an architecture. You have seen that different tasks are involved in instructional design, such as needs assessment, collecting information about distance learners, stating learning outcomes/objectives, systematic presentation of collected information or data. These tasks require scientific thinking, and, therefore, ID is considered a science.

Role of an instructional designer

An instructional designer has to carry out different *roles* while designing instructional materials for distance learners. These are:

- Designing a blueprint of a programme/course;
- Discuss the approach, models and theories with distance learners, teachers, academics, subject experts and media specialists;
- Creating an architecture for the arrangement of content within the instructional framework;
- Creating a design to present information/content to the students with interactive and access devices based on learning outcomes;
- Designing multimedia and selection of media components;
- Demonstrating the procedures of navigating learning management system (LMS) platform; and
- Creating open courseware content.

The theories and instructional design models help an instructional designer to create instructional events while preparing self-learning materials for distance learners, who have different learning experiences, learning styles and preferences. Therefore, an instructional designer has to play an important role. He/she has to work collaboratively with the subject matter experts (SME), media specialists, as well as the distance learners.

5.4 THEORIES AND MODELS OF INSTRUCTIONAL DESIGN

In the above section, we have discussed the concept of ID. In this section, we will present different theories and models of instructional design to help you understand how a theory can be used while designing instruction.

According to Andrews and Goodson (1980), instructional design models serve the following four purposes:

1) Improving learning and instruction using the problem solving and feedback characteristics of the systematic approach.
2) Improving the management of instructional design and development through the monitoring and control functions of the systematic approach.
3) Improving the evaluation process through the designated components and sequence of events, including the feedback and revision events, inherent in models of systematic instructional design.
4) Testing or building learning or instructional theory through theory-based design within a model of systematic instructional design.

Adoption of a specific instructional design model helps members of the instructional design team to communicate in a language understood by all. Models also provide conceptual and communication tools to manage the processes of creating quality instruction. Models guide us on what to do in a step-by-step manner and inspire us to question and inquire into the validity of the claims that the models make.

Another important aspect that we should always remember is that instructional design models are different from theories of instructional design, and a model may include one or more theories of instructional design.

Why a model of ID?

Following a specific and appropriate model for designing instruction or courses or programmes or curriculum provides the designers or a teacher with certain advantages. The advantages of a model are:

- It identifies the key components/steps that should be considered in sequential order. For example, Keller's ARCS model (A-Attention, R-Relay sequence, C-Confidence, and S-specification).
- It serves as a procedural guide for the instructional designers who are directing the faculty, subject experts, academics and media specialists.
- It allows those involved to understand 'where they are' in the process and their role within it.
- It improves efficiency by reducing duplication of effort and ensuring that critical questions are asked and alternative solutions explored for quality instruction.

Characteristics of ID Models and Theories

There are certain characteristics of these models and theories that are used for classification. These characteristics are:

- The amount of preliminary analysis conducted;
- Identification of learning outcomes/objectives;
- Analysis and sequences of learning outcomes/objectives;
- Typical output in terms of the amount of instruction prepared;
- Analysis of subject matter;
- Quantification of conditions and treatment;
- Compatibility with different theories of learning;
- Resources committed to the development efforts;
- Team or individual effort;
- Instructional design skills experience expected from the individual or the team members;
- Technical complexity anticipated in the development of learning environment;
- Amount of tryout and revision required; and
- Dissemination and follow up afterwards.

5.4.1 Gagne's Nine Events of Instruction

Robert M. Gagne suggested nine events of instruction to represent external teaching activities that support a student's internal mental processes of learning. The nine events of instruction are:

1) **Gain Attention:** In order to help the learners to learn better, it is important to gain their attention. Some of the ways to grab the attention of the learners are storytelling, demonstration, presenting a challenging problem, making them do something differently.

2) **Describe the goal and inform the learner of the objectives:** Informing learners about the objectives helps them to know in advance what they are going to learn and what is expected of them at the end. Also, it is a cue to the instructor to state what he/she will teach the learners, and then instruct them, and then review and assess their learning at the end.

3) **Stimulate recall of prior learning:** Concepts, facts, principles, and processes learnt earlier, are the pre-requisite for learning new concepts, and processes should be recalled before new learning can occur. The instructor can do this by asking questions, by stating the concepts or by doing a review, of what has been learnt so far.

4) **Present the learning material:** Information is presented to the learner in small chunks from simple to complex sequence.

5) **Provide guidance for learning:** This step is to allow the learners to comprehend and assimilate the materials presented. Thus, the instructor needs to facilitate learning by providing guiding steps.

6) **Elicit performance:** In this step, the instructor asks questions to elicit learners' understanding of the material presented.

7) **Provide reinforcement:** This is to check whether the learners' performance is right or wrong. In this stage, specific feedback should be provided.

8) **Assess performance:** Here the terminal evaluation/examination of the achievement of objectives is done using some tests.

9) **Enhancing retention and transfer:** According to Aronson and Briggs (1983) "Instructional designers cannot assume that learners will be able to transfer learning from one situation to another; such retention and transfer should be included as part of the instruction. For intellectual skills, providing spaced reviews helps. For verbal information, providing linkages between information learned at different times is recommended" (p. 92).

R.M. Gagne's nine events of instruction applied to online courses have been tabulated in Table 5.1.

Table 5.1: Gagne's nine events of instruction applied to online courses

Events of Instruction	Strategies for Online Courses
1) Gain attention	Present the students an interesting and relevant problem, idea, event, or situation to develop their interest.
2) Describe the goal	Describe the goal or objective of the lesson. State what students will be able to accomplish and how they will be able to use the knowledge. Make the learners aware of expectations.
3) Recall of previous knowledge	Remind the student of prior knowledge relevant to the current lesson (facts, rules, procedures or skills). Provide the students with a framework that helps in the retention and retrieval of information.
4) Present the material to be learned	Use appropriate media for content such as text, graphics, simulations, figures, images, sound, video. Follow a consistent presentation style. Chunk information into logical segments.

Events of Instruction	Strategies for Online Courses
5) Provide guidance for learning	Help learners perform the task. Provide instructional aids, responses, or step-by-step instructions as support learning. Present information in a different medium or communication channel.
6) Elicit performance	Practice using new knowledge or skills. Produce a product. Repeat task or process. Respond to study questions.
7) Provide information	Provide specific instruction or peer feedback to analyze learner's behaviour. Provide a checklist.
8) Assess performance	Administer a formal or informal assessment plan to determine the mastery of knowledge or skill.
9) Enhance retention and transfer	Inform the learner about similar problem situations. Provide additional practice in the form of real-life situations. Put the learner in a situation to transfer knowledge. Review the lesson.

Adopted from the Source: Fuller, Kuhne and Frey, 2011.

5.4.2 Banathy's Design of Instructional Systems

The instructional design theory by B.H. Banathy, is one of the earliest theories (proposed in 1976). This theory places a lot of importance on a detailed statement of purpose, leading to development of the system. The system emphasizes clearly stated objectives, analysis of the entry behaviour of the learner and testing. Figure 5.1 depicts the ID theory proposed by Banathy, where the following steps are involved:

1) **Analysis and formulation of objectives:** The first step is to write down the purpose of the system and then outline what the learners will be able to do as a result of the instruction.

2) **Criterion test:** Prepare criterion-reference tests to measure the achievement of the objectives.

3) **Analysis and formulation of learning tasks:** Prepare a list of learning tasks that the learners must undertake to accomplish the objectives. In this step, the following activities are involved:

   - assess the entry behaviour through an input test so that the learners do not have to learn again what they already know; and
   - identify the learning tasks to be undertaken.

4) **Design the system:**

   - identify the process that will lead to learning;
   - analyze how to achieve this; and
   - identify the time and place for this functional training to be conducted.

5) **Implementation:** This is the stage of implementation of the training and evaluating the achievement of the performance of the learners. The results of the evaluation determine necessary changes required in other components of the system.

In this instructional theory, Banathy emphasized on the systems approach that is 'self-correcting,' and a logical process for the planning, development and implementation of instruction.

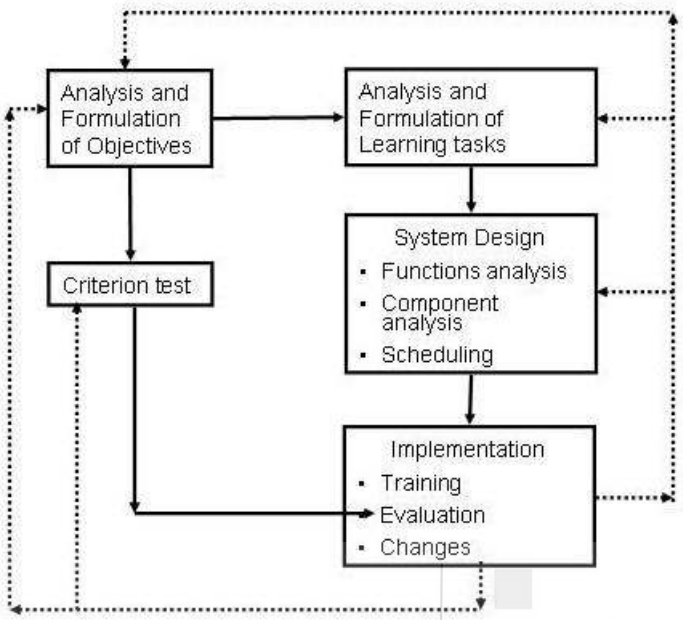

Fig. 5.1: Banathy's Design of Instructional System

Source: Course MES-056, Education Technology, Block 2, pp.74.

5.4.3 Keller's Motivational Design of Instruction

John M. Keller proposed that there are four basic categories of motivational conditions that provide a basis for a systematic approach to design motivational strategies. These conditions are *attention*, *relevance*, *confidence*, and *satisfaction*, often called the ARCS model (Keller, 1979). Figure 5.2 depicts the ARCS model, where the first step is to *analyze* the motivational problem in terms of the instruction and the student. The next step is to *design* motivational strategies, which is followed by *implementation* and *evaluation*.

In the motivational strategy of design, '*attention*' can be gained in two ways – by arousing the curiosity of the learner, and by using an element of surprise or uncertainty to gain interest. Some of the strategies to gain attention include storytelling, humour, active participation, questioning, examples, analogies, etc. The second major motivational condition is that of *'relevance'*. Pupils learn more if they think that the topic is relevant to their personal needs. To make instructions relevant and provide an opportunity for choice and responsibility, the individual should be able to assess the future usefulness and today's worth of learning. The next motivational strategy is about building the *'confidence'*. This strategy is to help learners succeed, and, therefore, instruction should be provided in terms of incremental complexity. The objectives should be clearly expressed and the feedback provided to support success and to develop learner confidence. The fourth motivational aspect is *'satisfaction'*, and instructional strategy would be to provide learners with opportunities to use the newly acquired knowledge or skill in the real world. Use of feedback and reinforcement increases intrinsic satisfaction with instruction. Other strategies should include formative evaluation and creating a non-threatening learning environment.

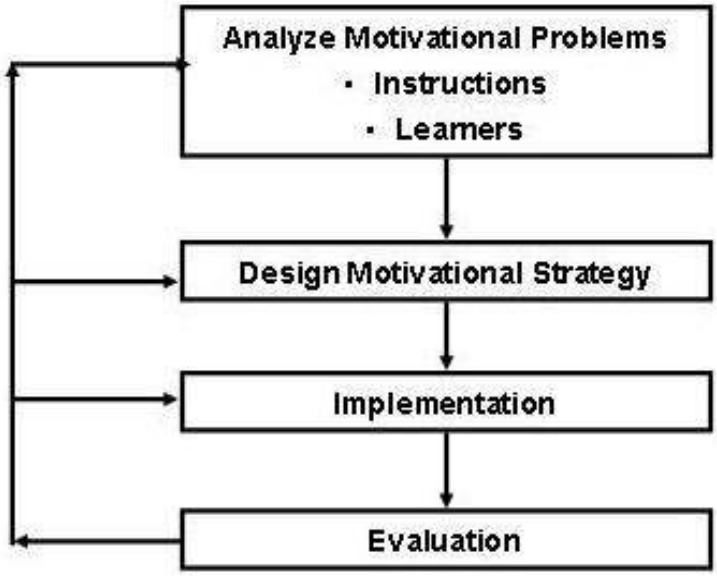

Fig. 5.2: Keller's Motivational Design of Instruction

Source: Reigeluth, C.M. (1983), pp. 396.

In the above sub-sections, you have gone through some of the common theories of instructional design. We can state that every theory advocates using of authentic and challenging tasks, that require you to think and act with information as the basis of instruction. These theories give an emerging picture of the new paradigm of instruction. The diversity of theories of ID allows an instructional designer to select the task that best addresses the needs of specific instructional situation appropriate for distance learners. In the following sub-sections, we have presented you with four different models.

5.4.4 Dick and Carey Model

The most widely used ID model is published by Walter Dick, Lou Carey and James Carey for designing instruction systematically as depicted in Figure 5.3, the first step is to assess needs to identify goal(s). The identification of instructional goal focuses on using needs assessment procedures for stating clear and measurable goals.

The next two steps are parallel: Conduct an instructional analysis and analyze the learners and contexts. The former determines the skills involved in reaching a goal and deals with the identification of the tasks to be performed (procedural analysis) and mental operations used by a person. The latter determines the prospective learner's knowledge, skills, personality and the environment. The next step is to write performance objectives in specific, measurable and achievable terms. This step is followed by the development of appropriate instruments for assessment of the identified objectives. The criterion- referenced tests items generated for each of the objectives help to diagnose an individual's acquisition of learning during the process of a lesson and are useful in the formative and summative evaluation of the instructional systems itself.

The next step is to develop an instructional strategy. The different types of instructional strategy are: information presentation guidance, drill. practice and feedback. This step is about selection of instructional methods (teacher-led, cooperative learning, demonstrations, discussion, etc.) to match the objectives. The next step is to develop and select instructional materials. This step emphasizes appropriate

choice of printed and/or other materials to support instruction. This step also recommends identification and use of already existing materials and development of new ones, whenever required.

The next step is to design and conduct a formative evaluation of instruction to provide data for revision and improvement of instructional materials and the overall process of instruction. The authors recommend a variety of methods including interview and small group discussion for the purpose of formative evaluation. The 'revise instruction' step in the model is a supplement to the formative evaluation stage and continuously collects data during the tryout process to facilitate decision making and revision. The last step in the model is the design and conduct of summative evaluation that checks the effectiveness of the system as a whole and is holistic in nature. This step is mostly conducted at the end after some gap of time.

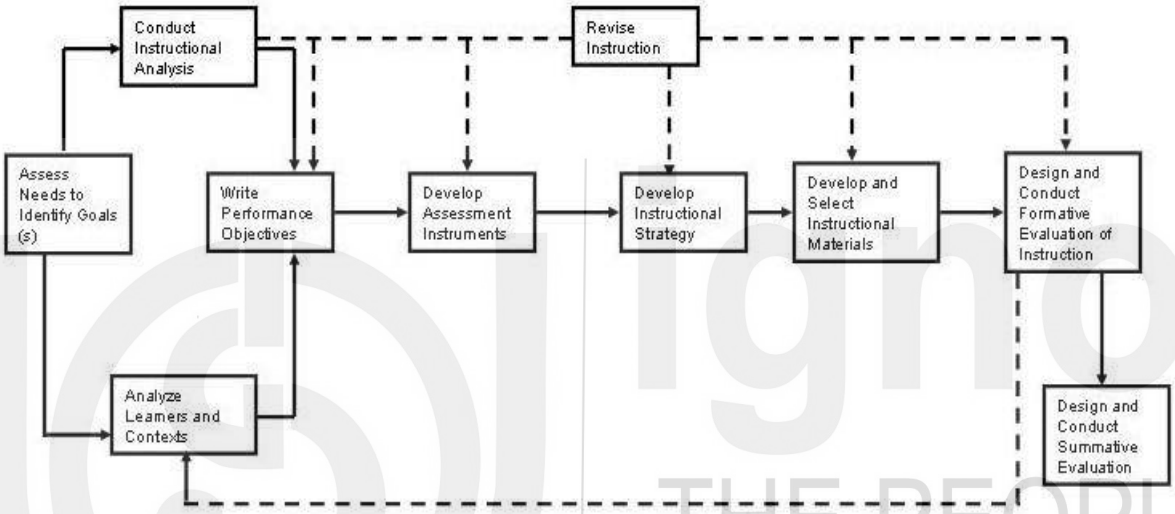

Fig. 5.3: The Dick, Carey and Carey Model (2001)

Source: Gustafson and Branch (2002) pp. 59.

Check Your Progress 2

Note: i) Write your answer in the space given below.
ii) Check your answer with the answer given at the end of this Unit.

List the components involved in the motivational strategy of design in Keller's ARCS model.

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5.4.5 Bergman and Moore Model

Bergman and Moore (1990) proposed the development model for the production of interactive multimedia (see Fig. 5.4 below). It is a systematic process that includes six major activities: analysis, design, develop, produce, author, and validate.

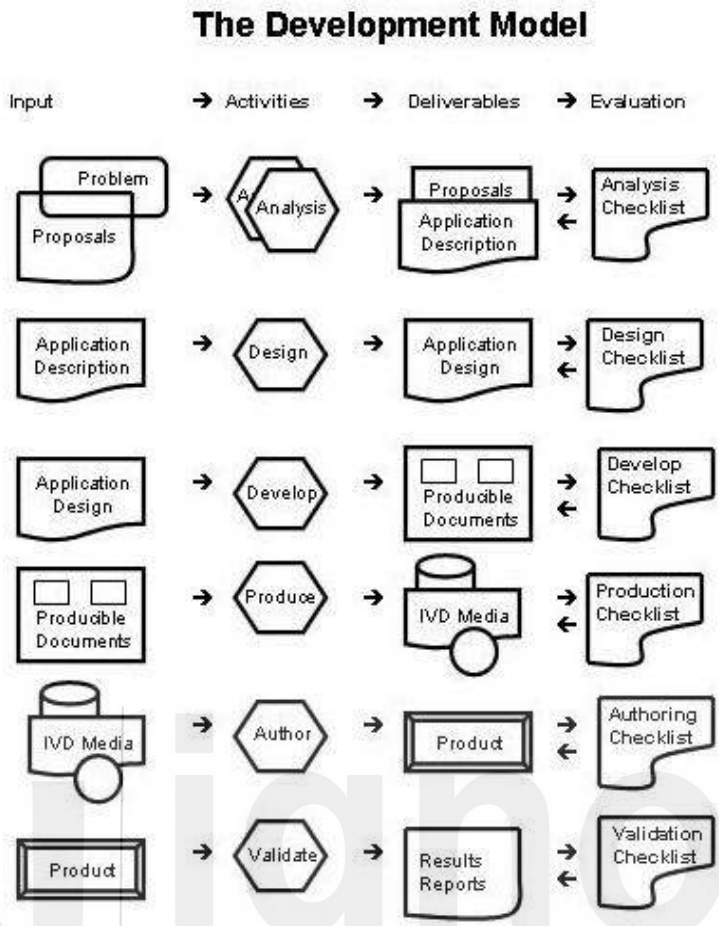

Fig. 5.4: Bergman and Moore Model

Source: Gustafson and Branch, 2002, pp. 33.

The output of each activity in the system becomes the input of the other activity. Thus Bergman and Moore model is a linear model but is represented in rows and columns. Each of the six activities in the model can be considered as stages, and each stage has some input, activity, production, implement, and evaluation.

The design activities take into account issues related to the sequencing of content, objectives, detailing out the message design and their treatment. This design essentially is a 'blueprint' and also includes all media, interaction and navigation strategies, assessment methodology, etc. In the *develop stage*, the application design is converted into specific strategies/approaches that can be productive. The *develop stage* will deliver multiple documents as storyboards, audio scripts, shortlists, etc. In the *production stage,* the multiple media elements are actually produced. In the *author stage*, these are integrated into one. The sub-activities in the author stage include coding, testing, and running. The *validation stage* consists of comparing the finished product with that of the original objectives and undertaking necessary revision.

5.4.6 Smith and Ragan Model

Smith and Ragan (1999) model of instructional design has *three* phases: analysis, strategy and evaluation. These three phases include *eight* steps, which are: analysing the learning contexts, analysing the learners, analysing the learning tasks, writing test items, determining the instructional strategies, writing and producing instruction, conducting formative evaluation and revising instruction (Fig. 5.5). The process is linear, in nature, from phase 1 to 3, but tasks within the phase may be concurrent as well. Analysis of context involves ascertaining the need for instruction in specific

content and description of the environment where the instructional product will be used. In the analysis phase, the characteristics of the learners are analysed, and learning tasks are broken down into appropriate instructional goals and objectives. At this stage, test items are also prepared to measure the achievement of the objectives of the instruction. In the second phase, instructional strategies are identified and implemented, including how to deliver the instruction and what methods and techniques to follow. Based on the strategies developed, instruction is produced and implemented. In the evaluation, the formative evaluation phase is conducted, and the results are ploughed back into the systems for revision of instruction.

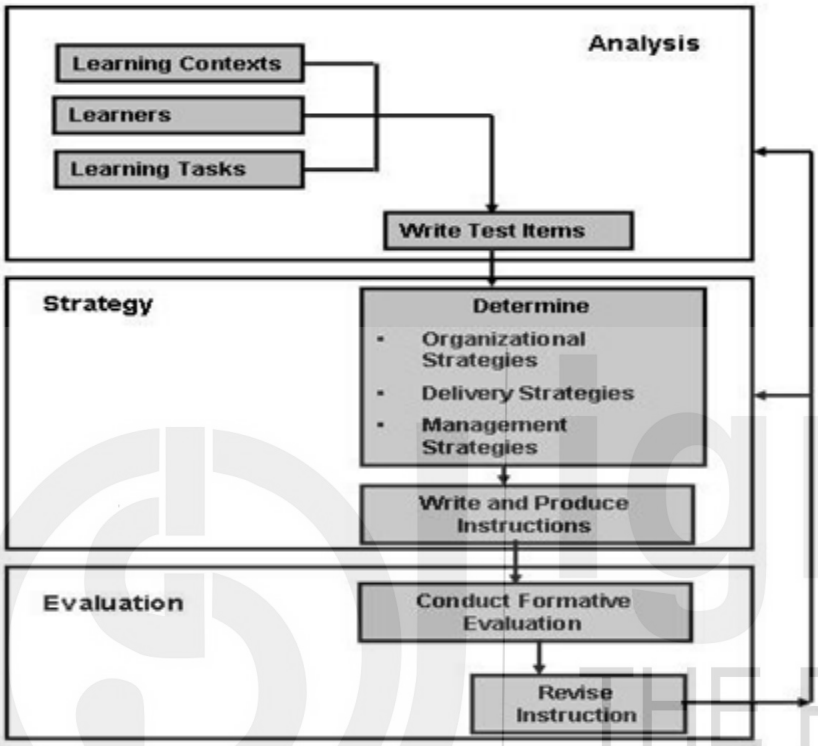

Fig. 5.5: Smith and Ragan Model

Source: Gustafson and Branch, 2002, pp. 58.

Check Your Progress 3

Note: i) Write your answers in the space given below.

ii) Check your answers with the answers given at the end of this Unit.

1) Discuss the six activities of the Bergman Moore model.

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2) Describe the three phases of the Smith and Ragan model.

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5.4.7 ASSURE Model

This model of instructional design is represented by the acronym ASSURE, which stands for Analyse, State, Select, Utilize, Require, Evaluate (Fig. 5.6).

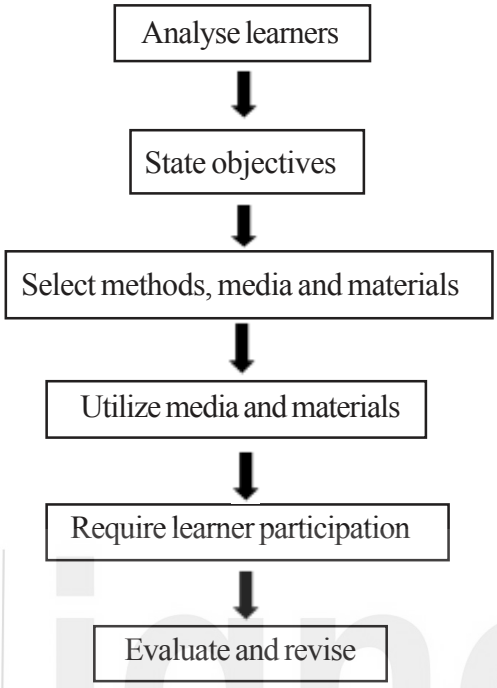

Fig. 5.6: ASSURE MODEL

Source: Gustafson and Branch, 2002, pp. 23.

The ASSURE model is similar to Gagne's nine events of instruction. It is a procedural guide for planning and conducting instruction in a classroom or academic counselling session that uses media. The first step in this model is to analyse the learners and understand their general characteristics, their entry competencies (knowledge, skills and attitudes), and learning styles. The next step is to state the objectives in measurable terms. The objectives should be stated in terms of what the learners will be able to do as a result of instruction. According to the model, a well-stated objective meets four criteria, called ABCD, where A is the *Audience* for whom the objective is intended, B is the *Behaviour* to be demonstrated, C is the *Condition* under which the behaviour will be observed, and D is the *Degree* to which the new skill must be mastered (Heinich, et al., 1999). Once the objectives are identified and stated, the next step is to select methods, media and materials to deliver the necessary content that will help in the achievement of the defined objectives. In a way, this stage is the bridge between the content and the objectives. At this stage, based on the need, new materials are also prepared.

The next stage is implementation where the selected media and materials are utilized in the classroom academic counselling session. But before that the materials must be previewed. It is at this stage that the instructor can include some of the instructional events of Gagne. The next step is a concurrent activity of the previous step. For the instruction to be useful and effective, the learners participation is required. Instructor's use of media and materials is not sufficient, and the learners should participate/engage in the learning process. Thus, there should be activities within the lesson/unit to encourage learner participation. The instructor should provide necessary feedback on the efforts put in by the learners before formally evaluating it. The last stage in this model is to evaluate and revise. This includes the assessment of the learner, achievement as well as the evaluation of the whole process of instruction. The result of both helps us to revise the instructional process.

Check Your Progress 4

Note: i) Write your answer in the space given below.
ii) Check your answer with the answer given at the end of this Unit.

Discuss the six stages of the ASSURE model.

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5.4.8 Constructivist Instructional Design Models

Most instructional design models discussed so far are based on behavioural and information processing learning theories involving well-structured procedures, with a major focus on learning environment reinforcement and situated learning. However, there is a growing body of literature on instructional design from the constructivist perspective (Winn, 1992). This literature focuses on constructivist learning environments (Jonassen,1999), anchored instruction (Cognitive Technology Group at Vanderbilt, 1993), problem- based learning (Savery & Duffy, 1995), goal-based scenarios (Schank & Cleary, 1999) and situated cognition (Brown, Collins, & Duguid, 1989). Herrington and Oliver (2000) identified *nine* elements to design a constructivist instructional design. These are:

1) Provide *authentic contexts* that reflect the way the knowledge is applied in real life.
2) Provide *authentic activities*.
3) Provide access to *expert performances* and the modelling of processes.
4) Provide *multiple roles and perspectives*.
5) Support *collaborative construction of knowledge*.
6) Promote *reflection* to enable abstraction to be formed.
7) Promote *articulation* to enable tacit knowledge to be made explicit.
8) Provide *coaching* and *scaffolding* by the teacher at critical times.
9) Provide for *authentic assessment* for learning within the tasks. (pp. 25-26).

The above elements are used in the design and development process in a specific context. The instructional designer also uses the reflective practice – reflection-in-action and reflection-on-action (Schon, 1987). Thinking about our work and what we are doing leads us to reformulate the problem/tasks in hand. The participation guidelines of the model are a little difficult to implement, as it proposes that the learners should be involved in the design process. However, a participatory design is highly significant and useful for specialized training in technical and behavioural aspects. It also improves learning due to ownership of the design by the participants.

To summarize the above discussion, the constructivist ID models foster the learner's construction of knowledge and can be applied in designing instructional materials. It

involves selecting relevant information, organizing it and integrating it with existing knowledge. These models focuse on ways to develop instructional materials for print/ text or multimedia to support the distance learners. It is up to the instructional designer to accommodate the best of different approaches and models in his/her practice.

Check Your Progress 5

Note: i) Write your answer in the space given below.
ii) Check your answer with the answer given at the end of this Unit.

Discuss the major elements of Constructivist Instructional Design Models.

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5.5 LET US SUM UP

In this unit, we discussed instructional design as a process. We defined instructional design as a systematic process of designing instructional solutions by identifying the instructional problems, specifying objectives, identifying methods, media and strategies to deliver instruction. We also considered the importance of formative and summative evaluation to receive continuous feedback about the learning process and assess its overall quality. We discussed a few selected models of instructional design. We briefly discussed the constructivist approach to instructional design in this unit. By combining the constructivist approach with the basic principles and appropriate instructional design model, the instructional designers can design effective instructions in most situations. Though we also understand, that none of the ID models fit in all the situations, thus, it is the situation and the problem in the hand that will guide you as instructional designers to use an appropriate instructional design model.

5.6 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1) Please see section 5.3. According to Charles M. Reigeluth instructional design is defined as:

   Instructional design is concerned with understanding, improving and applying methods of instruction.

2) Please see section 5.3. The aspects to be kept in mind while preparing a blue print for designing instruction are:

   - Who (the learners; diversified and heterogeneous group);
   - When (the sequence of instructional events that should occur);
   - How (the strategies, methods and media should be used); and
   - What (instruments and strategies should be used for assessment).

Check Your Progress 2

The components of design motivation strategy are: attention, relevance, confidence, and satisfaction.

Check Your Progress 3

1) Please see sub-section 5.4.5. The Bergman and Moore model has six major activities: analysis, design, develop, produce, author, and validate.

2) Please see sub-section 5.4.6. The Smith and Ragan model has three phases: analysis, strategy and evaluation.

Check Your Progress 4

This model of instructional design is represented by the acronym ASSURE, which stands for Analyse, State, Select, Utilize, Require, Evaluate.

Check Your Progress 5

Please see sub-section 5.4.8 and write about the nine elements of constructive instructional design models.

UNIT 6 COMPONENT DISPLAY THEORY (CDT)

Structure

6.1 INTRODUCTION

In the previous Unit 5, you have studied different models of ID. In sub-section 5.4.4, we have discussed the Dick and Carey Model. In this model, you have read about the instructional process and instructional strategies.

The acquisition of different types of knowledge and skills requires different conditions for learning. If the instructional process includes the instructional strategies required for the acquisition of the desired knowledge and skills, then effective, efficient and appealing learning occurs. Instructional strategies ensure that programmes/courses are developed such that the learner acquires the knowledge, skill, or attitude intended by the instructional objectives. These objectives provide a means for determining the 'why?' and 'how?' components for the identified programme needs. Therefore, instructional strategies are crucial for both the learner and the instructional designer. The instructional designer analyses the content and conditions that support the instructional system, such as content, the learner, etc. to the intended learning outcomes. This process has two goals – the first goal is to simplify the components to be learned, and the second goal, to translate them into process or method. This is done by identifying content components, then classifying them based on the nature of the content, the learner, and the instructional objectives and goals. In this Unit, we will discuss the component display theory (CDT) of instructional design. This theory deals with the components for presenting content with objectives and instructional sequences. We have also described the new version of CDT, i.e., A Pebble in-the-Pond approach for designing courses/ programmes.

Adapted with permission from Merrill, M.D. (1983). Component display theory. In C.M. Reigeluth (Ed.), *Instructional-design theories and models: An overview of their current status* (pp. 279-333). Hillsdale, NJ: Lawrence Erlbaum.

6.2 LEARNING OUTCOMES

After going through this unit, you should be able to:

- discuss the facet of Component Display Theory (CDT);
- describe performance-content classification;
- draw a performance-content matrix;
- apply the principles of CDT for distance learning materials; and
- explain a Pebble-in-the-Pond approach.

6.3 COMPONENT DISPLAY THEORY (CDT): AN OVERVIEW

In this section, we will discuss the component display theory (CDT) for its relevance to the development of instructional materials in distance education. We will also discuss the performance-content matrix and the different dimensions of CDT.

The prescriptive instructional design theories prescribe optimal methods of instruction for different combinations of conditions and desired outcomes. It emphasizes what components the instructional designer should use for designing the learning environment. These components could be facts, concepts, procedures and principles. A design theory improves instructional methods and helps to provide effective and efficient instruction. Instructional Design theories such as the Component Display theory (CDT) and the Elaboration Theory (ET) are two examples of design science.

The CDT integrates knowledge about instruction and learning from all the three major theoretical perspectives: behavioural, cognitive and humanistic (Ref. Block 1, Units 2 & 3). This theory was propounded by M. David Merrill in 1983.

This theory addresses the following issues. They are:

- Classification of learning outcomes (content and performance).
- Presentation forms, consisting of presentation modes and presentation elements.
- Methodology prescriptions.

6.3.1 Dimensions of CDT

The component display theory is a very comprehensive prescriptive theory, which deals with methods of organizing more than one idea. Merrill integrated most of the existing knowledge in such a way that it would improve our ability to design more effective instruction. The theory benefits from previous knowledge accumulated in other areas, such as performance, task analysis, taxonomies, content analysis, and strategy selection. The theory provides principles for the optimal combinations of presentation strategy components for effective and efficient instruction at the micro level. CDT is relevant to instruction and training in the cognitive domain.

The heart of CDT is the performance-content classification system as shown in Fig. 6.1. In this figure, you can see that the three performance levels are: remember, use, and find.

Four content dimensions are: fact, concept, procedure, and principle. These categories are discussed brlow:

1) Content Categories

The different content categories are as follows:

- ***Facts**:* A fact is a piece of information that is assumed to be true and is presented without any evidence. Facts state specific information about people, places, and events that already exist. Examples of facts are:
  - i) Newton is the inventor of the 'Law of Gravity'.
  - ii) There are five vowels in the English language.
  - iii) New Delhi is the Capital of India.

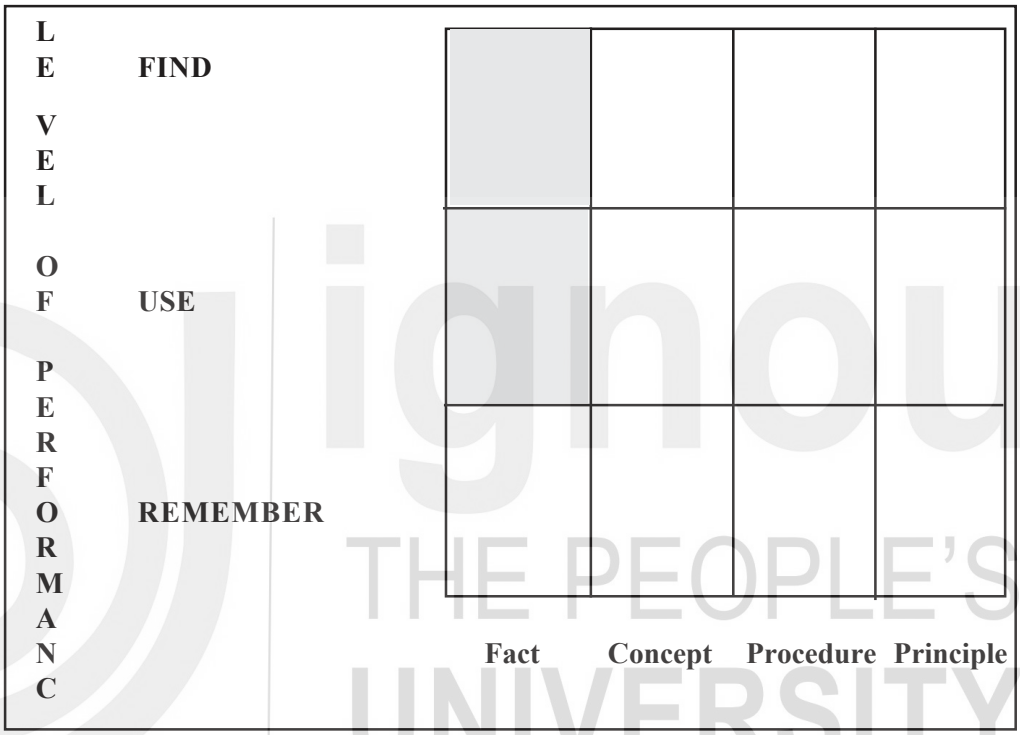

Fig. 6.1 Performance-content matrix

Source: M. David Merrill, 1983, pp. 286.

- ***Concepts*:** Concepts are groups of objects, events or symbols that have common characteristics/attributes and are identified by a common name. Some examples are a table, democracy, an angel, etc. Here, while learning a concept, the learner responds to stimuli by identifying its concern as well as abstract characteristics like shape, colour, features, functions, etc.
- ***Procedures:*** A procedure is an ordered sequence of steps to complete a task or to find a solution to a problem. For example, steps to prepare an assignment response, steps to design a unit, and steps to draw a triangle.
- ***Processes:*** A process is a series of events, stages or phases that take place over a period of time. Processes describe how things work instead of how you should perform the steps. For example, selecting a book in a bookshop, information processing in a computer and describing the life cycle of a butterfly with the help of a flow diagram.
- ***Principles:*** A principle is a content category that can be stated in the form of rules to guide certain actions or explain some changes. For example, rules for playing football; do's and don'ts for using a computer, guidelines for writing a project report.

2) Performance Categories

The different categories of performance are as follows:

- ***Remember*** is the performance that requires the student to search memory in order to reproduce or recognize some item of information that s/he previously stated.
- ***Use*** is that performance that requires the student to apply some abstraction to a specific area.
- ***Find*** is that performance that requires the student to derive or invent a new abstraction.

For example, *our goal is to present principles or facts* from geography. The instructional designer must select learning activities and organize learning activities that enable the learners to remember the information and use the skill for locating different places on a map while receiving instruction.

Check Your Progress 1

Note: i) Write your answers in the space given below.
ii) Check your answers with the answers given at the end of this Unit.

1) Discuss the content categories of CDT.

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2) Describe the performance categories of CDT.

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Presentation Forms

In the above discussion, we have described two components of CDT: a category system for subject matter and a set of categories for student performance. The third component is presentation forms.

This is based on the idea that the different types of content can be learned at different levels of behaviour, and different strategies are required for each content type and task level.

According to Merrill, the important presentation strategy variables are first discussed, and labelled as 'primary presentation forms'. Also, the adequacy of presentations and the consistency among objectives, presentations and tests were facilitated through the use of task/content classification.

Merrill identified *four* primary presentation forms. These are: generality, generality practice, instance, and instance practice. A generality is defined as an abstract or general statement that can be applied in a variety of specific situations, such as the definition of a concept, or the statement of a procedure or a principle. Every generality has at least two specific situations associated with it. An instance is the application of that generality to new situations, and practice is applying that generality to different situations (Merrill et al., 1979). Merill also identified secondary strategy components, which are elaborated or helped by primary presentation forms. These secondary strategy components are labeled as 'helps' and include 'mnemonic help' (For example, ARCS, where A-Attention, R-relevance, C-confidence and S-satisfaction), alternative representation help, etc.

The following questions for adequate presentation of instructions are stated as:

- What adequate *primary* presentation forms should be used for teaching at the desired task level? For example, for an objective like teaching at remember-an-instance task level, the appropriate primary presentation forms are instance and instance practice.
- What *secondary* strategy components should accompany each primary presentation form? For example, for the same objective mentioned above, the inclusion of some memory aids like rhymes, chunking devices, etc., helping the students to remember the given instance.
- What characteristics should each of these primary strategy forms have? For example, for an objective at the use-a-generality task level, the instance should be presented with all critical attributes in order to make it possible for the student to compare relevant and irrelevant attributes.

On the basis of all this information, we can see that this instructional theory (CDT) at the micro-level includes the following components:

- Information presentation (it could be either a generality or an instance)
- Example (this should be included in instruction if it is necessary, depending on the difficulty level of the subject matter and/or the ability level of the learner); and
- Feedback (of course, each practice item is followed by immediate feedback).

The above discussion emphasizes that component display theory (CDT) is a set of prescriptive relationships used to guide the design and development of learning activities. What are the learning activities? Learning activities are events in which the learner must participate in order to achieve the objectives, and tests are events that assess the degree to which the student achieves the objectives.

CDT also emphasizes that instruction is more effective when it contains all the primary and secondary forms. Thus, objectives are followed by a combination of rules, examples, recall, practice, feedback, helps, and mnemonics, suitable to the content of a subject and learning task.

A significant aspect of the CDT framework is *learner control*, that is, the idea that the learners can select their instructional strategies in terms of the content and presentation components. In other words, instruction designed according to CDT provides a high degree of individualization as learners can adapt learning to meet their own learning styles and preferences.

6.4 CDT AND INSTRUCTIONAL STRATEGIES

According to Merrill, the four primary instructional strategy forms are:

- Presentation (tell);
- Demonstration (show);
- Recall (ask); and
- Apply (do).

The instructional outcomes for each type of instructional strategy as suggested by Merrill (2007) are as follows:

For kinds of content the presentation is tell a definition (information); the demonstration is to show an example (portrayal); the recall is remember the definition (information); and the application is classify a new example (portrayal).

Merrill (2007) has also suggested an integrated task-centred instructional strategy that incorporates strategies for learning different knowledge components. How can these knowledge components be combined to form a task-centred instructional strategy? We have discussed about task-centred strategy in section 6.5.

Therefore, Merrill's different presentation forms are: Primary Presentation Forms (PPFs), Secondary Presentation Forms (SPFs) and Inter Display Relationship (IDRs):

- PPFs consist of expository generality (rule), expository instance (example), inquisitory generality (recall), and inquisitory instance (practice).
- SPFs consist of information added to facilitate learning such as attention focusing help; mnemonics, and feedback.
- IDRs are sequences involving example and non-example matching, example divergence, and range of example difficulty.

For each performance-content classification, CDT prescribes the combination of PPFs, SPFs and IDRs. The combination of these three strategies is essential for most efficient and effective instructional strategies.

Check Your Progress 2

Note: i) Write your answer in the space given below.
ii) Check your answer with the answer given at the end of this Unit.

What do PPFs consist of?

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*6.5 CDT: RECENT DEVELOPMENTS

In Unit 1 and 5 we have discussed *first principles of instruction* suggested by M. David Merrill. These principles are activation demonstration, application and integration. The tasks is central to the above principles.

Merrill (1994) had presented a new version of CDT, which focuses on *Course Structures* (instead of lessons/units) and *instructional transactions* rather than presentation forms, as discussed in the previous section. The advisor strategies have taken the place of learner control strategies. This new version of CDT is related to work on expert systems and authoring tools for ID.

6.5.1 A Pebble-in-the-Pond approach

A Pebble-in-the-Pond approach to instructional development prescribes a task-centered, content-first instructional design procedure. This approach integrates previous instructional strategy prescriptions from the Component Display Theory with the content components of knowledge objects. The application of this component analysis and task- centered instructional strategy is discussed below:

Pebble-in-the-Pond Approach to CDT of Instructional Design

The Pebble model is a content-first approach. The first step in this approach is to identify a collection of real-world tasks that will later form the actual content of the instruction. There are four steps for designing instruction.

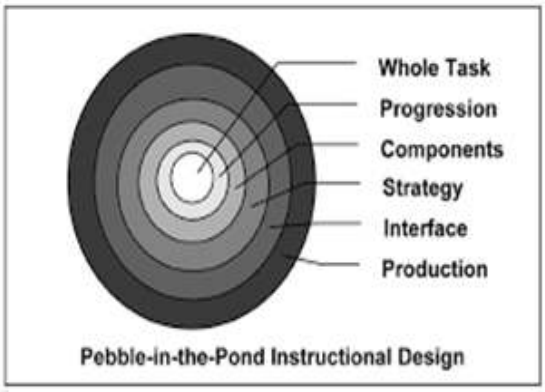
The *first step* identifies a typical whole task and produces a fully worked out example of that task. The *second step* identifies a series of similar tasks of increasing complexity. The *third step* identifies component skills common to these tasks, while the *fourth step* specifies the instructional strategy for the task-centered instruction approach. Figure 6.2 elaborates the first four ripples in this design approach. These are:

1) Specify a real-world task;
2) Identify a progression of tasks;
3) Specify component knowledge and skill for each task; and
4) Specify an instructional strategy for task-centered instruction.

The first three steps in the Pebble-in-the-pond approach are concerned with the first principle of task centered instruction, and specify how this material will be presented. Starting with whole tasks assures that the component knowledge and skill to be taught are relevant and integrated. Only in the fourth step, after the content has been identified and specified, does the pebble model specify the instructional strategy to teach this content.

Effective instructional strategies for the whole tasks and for the component knowledge and skill that comprise these tasks require, consistent *demonstration* and *application* at both the individual component level and at the whole task level. The instructional strategy described in this emphasizes *demonstration* and *application* of knowledge.

***Adapted with permission from M.D. Merrill (2007). A Task-Centered Instructional Strategy, *Journal of Research on Technology in Education, 40(*1), pp. 5-22.**



Source: M.D. Merrill (2007). A Task-Centered Instructional Strategy, *Journal of Research on Technology in Education, 40(*1), pp. 5-22.

Figure 6.2 indicates that the Pebble-in-the-Pond design approach consists of a series of expanding activities initiated by first casting in a pebble, that is, a **whole task** or **problem** of the type, that the learners will be taught to accomplish, by the instruction. Having identified an initial problem, the *first ripple* in the pebble model identifies a specific complete real-world task. What is a real-world task? A real-world task is one that a learner can expect to encounter in his/her life following instructions.

The *second ripple* in the pebble in pond design model is to ispecify a progression of tasks. Each task in the progression involves problems of increasing difficulty or complexity similar that if the learners are able to do all the whole tasks thus identified, they will master the knowledge and skill to be taught.

The *third ripple* in the design pond is to identify the component knowledge and skill required to complete each task or solve each problem in the programmes, and help them acquire the component knowledge and skill required to complete the tasks or solve the problems.

The *fourth ripple* is to specify an instructional strategy for task-centered instruction.

The *fifth ripple* is interface design. It is at this point in the design process that the content to be learned and the strategy used to engage learners are adapted to the delivery system and instructional architecture of the learning situation or product i.e., the sixth ripple.

The ripples have now expanded sufficiently to engage in the production of the instructional materials or situation. In the Pebble-in-the-Pond approach the content to be learned is specified first. One unique characteristic of this approach is casting in the problem or whole-task pebble and specifying a progression of such whole tasks. Pebble-in-the-Pond is primarily a design approach. The instance of instruction is the pebble thrown into the pond; the ripples from that pebble are the subsequent steps provided in the desiqn process.

Instructional Strategy

The implications of this approach in the design process is that, all the content that will enable the learner to acquire the desired knowledge and skill should be identified and specified. Another unique aspect of the Pebble-in-the-Pond approach is that this is a complete content specification, including all the information and portrayal that will be used in the instruction. An instructional strategy consists of combining four modes or instructional interaction with the components of knowledge to be taught: tell, ask, show, and do. The demonstration phase of instruction is to tell the learner information components and show the learner portrayal components. The application

phase of instruction is to ask the learner to remember information components (the most common but usually inadequate form of practice) and to have the learner use information components to do something with the portrayal components. In addition, an appropriate sequence for presenting the knowledge components. Instructional strategy also specifies appropriate learner guidance and coaching during the demonstration and application phases of instruction.

6.6 IMPLICATIONS OF CDT FOR DESIGNING INSTRUCTION

According to Rita Richey, CDT provides a basis for creating specification for the design and development of instructional materials

1) CDT is generic to all types of subjects and settings, and addresses very specific aspects of presenting instructional sequences.
2) It provides guidelines for making detailed design decisions.
3) This theory provides design for group instruction/group learning with the assumption individual learner that will control both content and presentation strategies.
4) The theory can be applied to the design of programmes, courses, teaching materials or individual lesson and individual units.
5) CDT provides a comprehensive set of models that integrate research-based principles to improve the professional's ability to design better instructions. This instructional design theory is selected for its relevance to the following important instructional contexts in open and distance education.
    i) When developing instructional materials for distance education, clarity in the presentation of textual information in terms of content, readability and teaching effectiveness, should be taken into consideration. These materials, unlike a usual textbook, should include self-teaching elements for students who are working primarily on their own.
    ii) Sequencing of the subject matter is another important aspect to be considered. As we all know, the textbook as a reference source of information follows a logical sequence, which does not help students very much to understand the content. This is a typical pattern generally used by subject matter specialists.
    iii) One of the most important contributions of CDT is the provision of a comprehensive set of clearly labelled, described and classified instructional variables. The classification helps the designers by indicating what kind of strategy components should be included in the design; what kind of conditions may influence the effect of each strategy component; and how and when these strategy components should be used.
    iv) The pebble-in-the-pond approach to instructional design provides steps for designing instruction and offers a different approach to content analysis.

Check Your Progress 3

Note: i) Write your answer in the space given below.
ii) Check your answer with the answer given at the end of this Unit.

Discuss the implications of CDT for designing instructions.

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6.7 LET US SUM UP

Component Display Theory has two categories. These are content categories and performance categories. The content refers to facts, concepts, procedures and principles, so, the performance-content matrix determines the level of performance and content. Each of the task levels requires different combinations of these presentation components based on the desired task levels and content types.

CDT is a comprehensive prescriptive theory. The instructional designer may decide to use a certain instructional design theory or a mix of theories at a theoretical level, but still it has to be translated in to the practical form of a lesson or topic. Instructional designers have to use various instructional strategies at the lesson or topic level to keep the interest of the learners alive and to facilitate learning. The instructional strategies that go into the design of a lesson or a topic range from expository to exploratory, from the use of analogies to the build-up of progressive display, and from concept stimulation to event stimulations.

6.8 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1) Please see sub-section 6.3.1. Elaborate on the aspects of content, which refers to facts, concepts, procedures,

2) Please see sub-section 6.3.1. Elaborate on the aspects of performance, which refers to remembering, using, and generalising.

Check Your Progress 2

Please read sub-section 6.4.3. PPFs consist of expository generality (rule), expository instance (example), inquisitory generality (recall), and inquisitory instance (practice).

Check Your Progress 3

Please see section 6.6.

UNIT 7 ELABORATION THEORY (ET)

Structure

7.1 INTRODUCTION

We know that the field of Instructional Science is concerned with understanding and improving the methods of instructional design so that the instructions can be more effective, efficient and appealing. In the previous Unit-6, component display theory we have discussed the presentation form or approach to the design of instruction. Here, in this unit, we will discuss the Elaboration Theory (ET) of instruction, which is given by Charles M. Reigeluth, whose major professional interest was to improve public education. He wanted an educational system that would place greater emphasis on well designed resources as the source of knowledge. This theory was designed to make scope and sequence decisions for relatively large chunks of instruction. It helps and guides an instructional designer to take decisions about when to sequence instructional events to make a difference, as well as when to use alternative methods for sequencing instruction.

7.2 LEARNING OUTCOMES

After going through this unit, you should be able to:

- discuss the concept of Elaboration Theory (ET);
- describe the different components which are utilized by elaboration theory;
- explain the characteristics of different components of the sequence;
- describe the elaboration sequence; and
- discuss the steps of developing an elaboration sequence.

7.3 ELABORATION THEORY (ET): AN OVERVIEW

The Elaboration Theory of instruction is designed to extend the Component Display Theory (CDT), which was introduced in Unit 6. We have already studied in previous unit about the Component Display Theory, and micro and macro-level strategies for organizing subject matter content. Hence, we know that the micro-level deals only with methods for teaching a single idea, and the macro-level deal only with methods that relates to several ideas, such as sequencing those ideas. The Elaboration Theory is exclusively for the macro-level which prescribes methods that deal with many related ideas and how to sequence these ideas. This theory makes no attempt to deal with either delivery or management strategies. Hence, it can be said that the Elaboration Theory deals only with organizational strategies at the macro level. The macro-level is made up mainly of four areas which are generally known as four S's. These are:

- Selection;
- Sequencing;
- Synthesizing; and
- Summarizing of subject matter content.

Thus, elaboration theory attempts to prescribe optimal methods in all four of these areas. The nature of elaboration theory of Instruction has an analogy with a zoom lens. According to C.M. Reigeluth, studying a subject matter through the elaboration theory model is similar in many respects to studying a picture through a zoom lens of a camera, where a person starts with a wide-angle view which allows him or her to see the major parts of the picture and the major relationships among those parts, but without any detail. When a person zooms in on a part of the picture, the zoom operates in steps or discrete levels. Zooming in on a given part of the picture allows the person to see more about each of the sub-parts of the picture. The person continues this pattern of zooming in to see the major sub-parts of a part and zooming out for context and review.

In a similar way, the elaboration theory of instruction starts the instruction with a special kind of overview of the simplest and most fundamental ideas within the subject matter. It adds a certain amount of complexity or detail to one part or aspect of the overview. It reviews the overview and shows the relationships between the most recent ideas and the ideas presented earlier. It continues this pattern of elaboration followed by summary and synthesis until the subject level of complexity has been reached on all desired parts or aspects of the subject matter.

Elaboration theory does not go through learning pre-requisites to teach the overview like Bruner's (1960) spiral curriculum because some un-mastered learning pre-requisites exist at the level of the overview. Let us discuss the origin of the elaboration theory before discussing different components of elaboration theory.

Elaboration theory creates a comprehensive set of macro-level models that integrate all of the above four areas in a way that greatly improves the ability to design good instruction.

Check your Progress 1

Note: i) Write your answers in the space given below
ii) Compare your answers with those given at the end of the unit.

1) What is Elaboration Theory?

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2) Why is Elaboration Theory compared with a zoom lens? Discuss.

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7.4 COMPONENTS OF ELABORATION THEORY

An instructional designer analyzes the content and conditions that support the instructional system. The first sequence is to simplify the components to be learned, second to formulate them into processes, which is done by identifying and clarifying the components. There are seven major strategy components which are utilized by Elaboration Theory.

7.4.1 An Elaboration Sequence

This sequence is a special type of simple to complex sequence, but there are many different ways to form a simple to complex sequence for a single course. The elaboration sequence has two characteristics these are: (i) the general ideas epitomize rather than summarize and (ii) the epitomization is done on the basis of a single type of content. These characteristics can be understood better by going through the given description.

- **Epitomizing Versus Summarizing –** Epitomizing differs from summarizing in two ways. Firstly, it is presenting a very small number of ideas that are to be taught in the course, and secondly, presenting them at a concrete, meaningful, applicable level. On the other hand, summarizing usually presents a considerably larger number of ideas at a more superficial, abstract and memorization level. Hence, to epitomize is not to lightly preview all of the important course content. Rather, it is to teach on an application level, complete with examples and practices, that enable the learner to relate it to previous knowledge and experience. Hence, only a few fundamental and representative ideas that convey the essence of the entire content would be able to use each of those principles to predict or explain novel cases.

  For example, an epitome for teaching an introductory course on Economics would be to learn the most fundamental and simple principle of Economics. The Law of Supply and Demand can be presented at the application level rather than the important principles of Economics.

- **Single Type of Content –** We know that there are three types of content – (i) concepts (a set of objects, events or symbols that have certain courses characteristics); (ii) procedures (a set of actions intended to achieve an end); and (iii) principles (which indicate the relationship between a change in one thing, and a change in something else; and, may also be called a hypothesis, proposition, rule or law). In an elaboration sequence, under the process of epitomizing, just one of the mentioned three types of content is chosen. The elaboration sequence is characterized as having a conceptual organization, a procedural organization or a theoretical organization in which the respective type of content is epitomized at the beginning of the course and gradually elaborated on in the remainder of the course, in such a way that most units not only elaborate on a previous lesson but also epitomize several later units.

In essence, it can be said that epitomizing entails – (i) Selecting one type of content, and listing all of the organizing content to be taught in the course; (ii) selecting a few organizing content ideas that are the most basic, simple, and fundamental; and (iii) presenting those ideas at the application level, rather than the more superficial and abstract memorization level.

Another important characteristic of epitomizing is the identification of very general ideas, neither detailed nor very simple ideas, neither complex nor concrete ideas, or abstract ones. Hence, in a nutshell, it can be said that the elaboration theory's 'special kind of overview' epitomizes a single kind of content. Also other kinds of content are included that are highly related to those epitomized ideas.

The process of epitomizing provides a kind of an overview, but here it is not called an overview, it is an epitome. The content for epitome is selected by epitomizing content to a small chunk, involving the other types of content that are highly relevant, including learning pre-requisites. Fig. 7.1 shows the content for a conceptual epitome.

1) Organizing content (concepts)

Kinds of measures

a) Elevation (or central tendency)

b) Spread

c) Proportion

d) Relationships

Kinds of methods of measures

a) Description

b) Estimation

c) Hypothesis testing

2) Supporting content

(Learning pre-requisites for the aforementioned concepts)

Practically all concepts in statistics can be viewed as elaboration on these concepts, through development of parts or kinds of conceptual structures.

Content for a Theoretical Epitome for an Introductory Course in Economics

1) Organizing content (principles)

The law of supply and demand

a) An increase in price causes an increase in the quantity supplied and a decrease in the quantity demanded.

b) A decrease in price causes a decrease in the quantity supplied and an increase in the quantity demanded.

2) Supporting content

The concepts of

a) Price

b) Quantity supplied

c) Quantity demanded

Practically all principles of economics can be viewed as elaborations on the law of supply and demand, including those that relate to monopoly, regulation, price fixing, and planned economies.

Fig. 7.1: Content for a conceptual epitome for an introductory course in statistics

Source: Reigeluth and Stein (1983).

As we know, the elaboration theory is similar to zooming, where zooming in process operates in steps or levels, which is known as levels of elaboration. Each level provides more details about the previous levels. Hence, in an epitome, the first level of elaboration elaborates on the organizing content to be presented in the epitome. The second level elaborates on the organizing content presented in the first level, and so on. Fig. 7.2 shows a partial example of level-1 lesson earlier shown in Fig. 7.1.

1) Organizing content (concepts)

Kinds of measures

a.1 Mean	*a.2 Median*	*a.3 Mode*
b.1 Variance	*b.2 Standard deviation*	
c.1 Percent	*c.2 Decimal*	*c.3 Fraction*

2) Supporting content

(Learning pre-requisites for the aforementioned concepts)

Additional elaborations would define kinds of methods for each kind of measure (e.g., methods of hypothesis testing for spread).

Content for an Elaboration on the Theoretical Epitome

1) Organizing content (principles)

a) Effects of changes in supply schedules at equilibrium price.
b) Effects of changes in demand schedules at equilibrium price.
c) The principle of why changes occur in supply schedules or demand schedules.

2) Supporting content

a) The concepts of supply, supply schedule, and supply curve.
b) The concepts of demand, demand schedule, and demand curve.
c) The concept of changes in supply schedules or demand schedules.
d) The concept of equilibrium price.

Beyond this point, elaborations would split into those that elaborate on the supply side (i.e., production and costs) and those that elaborate on the demand side (i.e., consumption and utility).

Fig. 7.2: Content for an elaboration on the conceptual epitome

Source: Reigeluth and Stein (1983).

Finally, a simple to a complex sequence based on epitomizing (rather than on summarizing) is prescribed, because it is hypothesized to make learning more meaningful and less rote, by effecting acquisition at the application level rather than the memorization level.

Check Your Progress 2

Note: i) Write your answer in the space given below
ii) Compare your answer with the answer given at the end of the unit.

Enumerate different components of Elaboration Theory.

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7.4.2 Learning Pre-requisite Sequence

A learning pre-requisite sequence is based on a learning structure or learning hierarchy (Gagne, 1968). A learning structure is a structure that shows what facts or ideas should be learned before any given idea is learnt. Hence, it shows the learning pre-requisites for an idea. For example, one can not learn the principle that force equals mass times acceleration (Force = Mass x Acceleration) until he or she has learned the individual concepts of mass, acceleration, and force.

Learning pre-requisites can be considered critical components of an idea. The critical components of the principle are (i) concepts and (ii) change relationships. The critical components of the concepts are (i) defining attitudes and (ii) their relationships (e.g., conjunctive and the disjunctive).

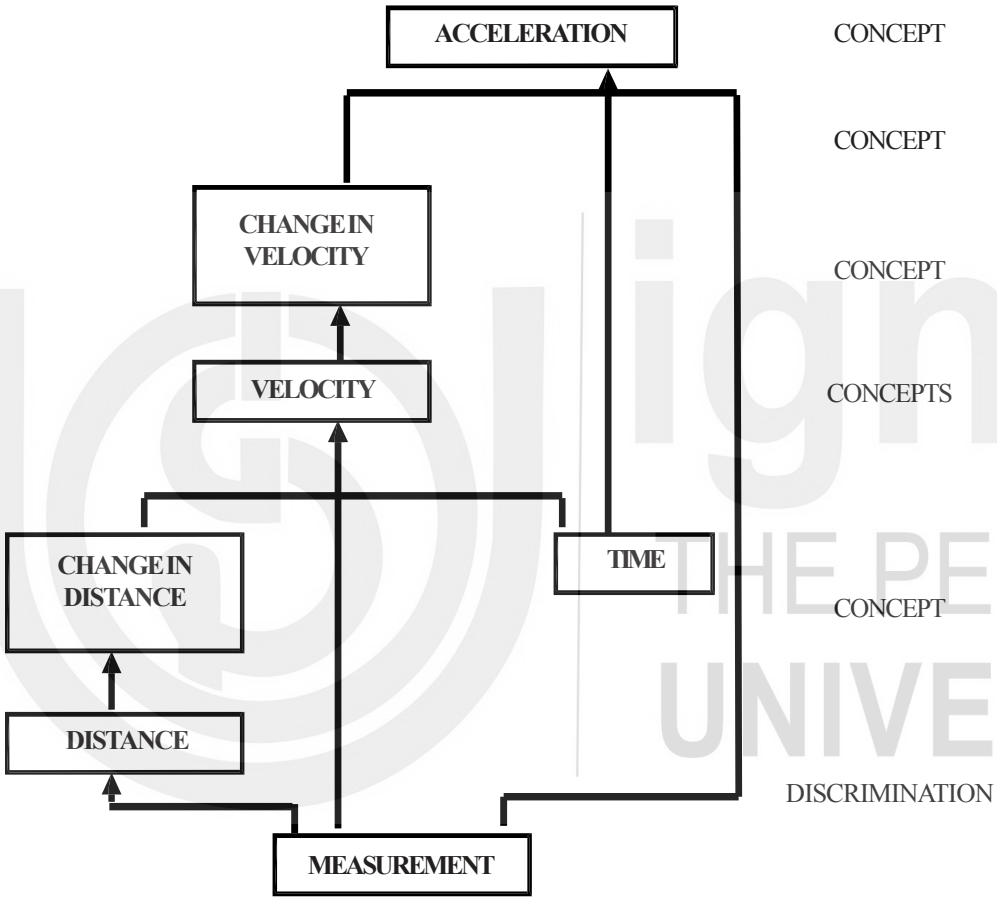

Fig. 7.3: An example of learning structure

Note: The arrow between two boxes on different levels means that the concepts in lower box must be learned before the concepts from higher box can be learned.

Source: Reigeluth and Stein, 1983.

A learning pre-requisite sequence is the presentation of content ideas in such an order, that an idea is not presented until after all of its learning pre-requisites have been presented.

7.4.3 Summarizer

We know that for minimizing the aspects of forgetting, a review is essential in instruction. Hence, in elaboration theory, a summarizer is a strategy component that reviews systematically the learned material to minimize forgetting.

- A reference example, i.e., a typical and easy to remember example for each idea.
- Some diagnostic, self-test practice items for each idea.

There are two types of summarizers. They are:

1) Internal Summarizer – This comes at the end of the lesson and summarizes only the ideas and facts taught in the lesson.

2) Within Summarizer – This summarizes all ideas and facts that have been taught so far in the sets of lessons on which the learner is recently working.

7.4.4 Synthesizer

In elaboration theory, a synthesizer is a strategy component for relating and integrating ideas. We know that, in instruction, it is important to periodically inter-relate and integrate the individual ideas that have been taught because it (i) provides students with a valuable kind of knowledge; (ii) facilitates a deeper understanding of the individual ideas through comparison and contrast; (iii) increases the meaningfulness and motivational effect of the new knowledge, by showing how it fits within a larger picture, and; (iv) increases retention (Asubel, 1964 Gagne,1978). A single type of relationship is advocated for each synthesizer so that the learner will not be confused. Hence, the kinds of relationships should be presented in a different synthesizer. For example, we can use a diagram to show the relationship by any given line, but when we give different kinds of relations, we have to show a table or matrix to combine them in a clear way.

In this way, new ideas are placed within the context of the previous instruction, through the process of periodic synthesis. It helps the learner to be continuously aware of the structure of the idea in the course and the relevance of each individual piece of knowledge to selected pieces.

7.4.5 Cognitive Strategy Activator

Cognitive strategies include learning skills and thinking skills that can be used across a wide variety of content areas, such as creating mental images and identifying analogies. Sometimes these cognitive strategies are called generic skills. These strategies should be activated during instruction. The two means of accomplishing these strategies are:

i) ***Embedded strategy activator:*** This includes the instructional use of pictures, diagrams, analogy, paraphrases, and other devices that force the learner to manipulate or interact with the content in certain specific ways.

ii) ***Detached strategy activator:*** This directs the learner to employ a previously acquired cognitive strategy, which improves the learner's acquisition and retention of the new content. The inclusion of detached strategy activator, along with a brief instruction on the use of those cognitive strategies, takes very little instructional time. It also increases both the effectiveness of the instruction and the learner's capacity to manipulate and understand other similar kinds of learning tasks.

7.4.6 Learner Control

The concept of learner control refers to the freedom of the learner for selection and sequencing of:

i) the content to be learned (content control);

ii) the rate at which a learner will learn (pace-control);

iii) the particular instructional strategy components she or he selects, and the order in which they are used (display control); and

iv) the particular cognitive strategies that the learner employs when interacting with the instruction (conscious cognitive control).

Elaboration theory emphasizes only three controls, i.e., (i) content control, (2) display control and (3) conscious cognitive control, but not pace control, which is a only controllable at micro-level.

Check Your Progress 3

Note: i) Write your answers in the space given below.
ii) Check your answers with the answers given at the end of this Unit.

1) What is learner control in elaboration theory?

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2) Explain the difference between summarizer and synthesizer in elaboration theory.

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7.5 DEVELOPING AN ELABORATION SEQUENCE

Before knowing about the development of an elaboration sequence, it is necessary to know about the concept of sequencing.

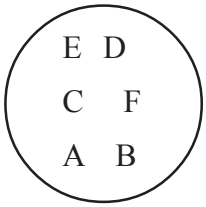
As we know, in the industrial age paradigm, the need was to break the content or task down into little pieces and teach those pieces one at a time. But in the information age paradigm, most of the new approaches to instruction require a more holistic approach to sequencing that can simplify the content or task, by identifying simpler real world versions of the task or content domain. The Elaboration theory was developed to provide a holistic approach to sequencing that makes the learning process more meaningful and conducive to learning.

Sequencing means how to group and order the content. We can't sequence the content without grouping, hence different kinds of sequencing require different groupings. Therefore, a decision must be taken about, what content should be presented, and what should be the scope for each grouping.

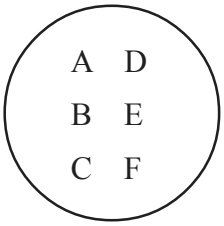
Thus, scope and sequence decisions involve several types of decisions which are described below.

1) The size of each group of content

2) The components of each episode



3) The order of components within each episode as A, B, C, D, E, F or A, B C, D



4) The order of episodes

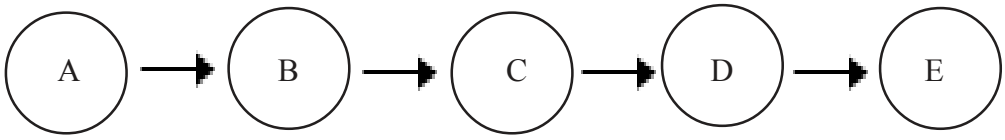


Fig. 7.5: Scope and sequence decisions: Types of decision

Source: Reigeluth, 1999

Scope is as important as sequencing because the content of the sequence should be as per the need of the learner/customer/trainee. Hence, the right content should be selected.

The impact of sequencing depends upon two major factors. These are:

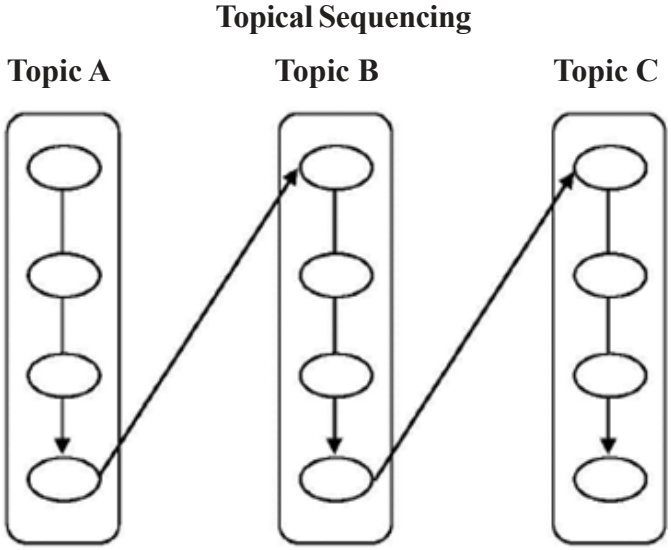
i) The strength of relationships among the topics, and
ii) The size of the course of instruction.

When, there is a strong relationship between the topics of the course, only sequencing is important. Suppose, there are many topics and these are strongly related to each other, it is very easy to learn the content. The second thing is where the size of the course of instruction is big but the relationship among the topics is well related then it becomes easy to learn. But if there is a fragmented approach for sequencing and those fragments are not related, it may be difficult to learn the relationship of the content.

When a number of topics need to be presented, two basic patterns of sequencing can be used as shown in Fig. 7.6. These are:

i) Topical sequencing: Here a topic is taught to whatever depth of understanding is required before moving to next.

ii) Spiral sequencing: Here the learner learns the basics of one topic, then another, then another.



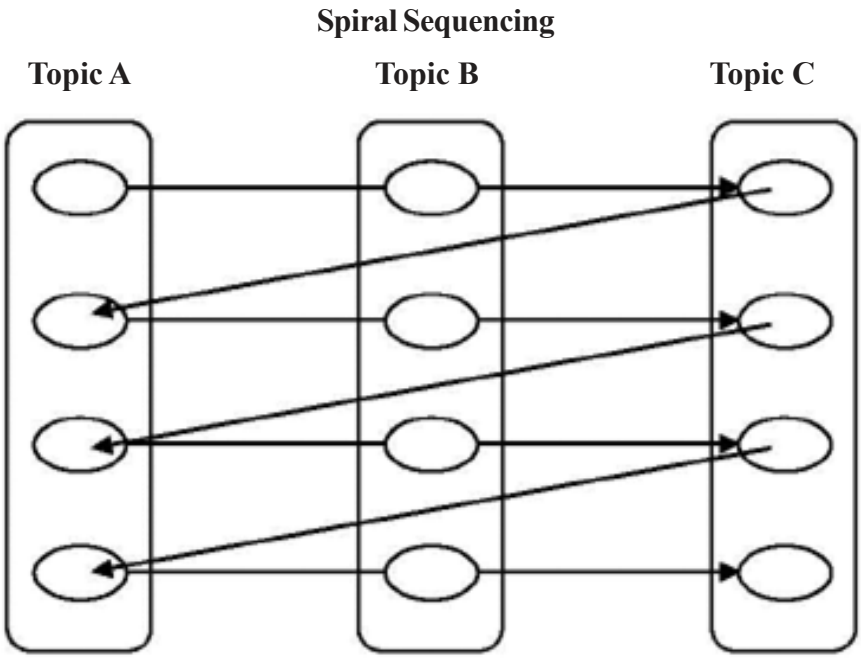


Fig. 7.6: Topical and spiral sequencing

Source: Reigeluth and Kim (1993)

Different sequencing strategies are based different kinds of relationships with the content and different kinds of expertise, i.e., task expertise and the subject domain expertise. Task expertise helps the learner in becoming an expert in a specific task, such as managing a project, setting a product, or writing a manual. The domain expertise helps the learner in becoming an expert in a body of subject matter because it ranges from general to detail. But elaboration theory recognizes two major kinds of domain expertise, i.e., conceptual and theoretical expertise. In conceptual expertise, conceptual knowledge structures for understanding 'what' and in theoretical expertise, principles for understanding 'why' are included.

Conceptual elaboration sequences

Asubel (1986) explains that learners incorporate new information into their cognitive structure. It is the main factor influencing the learning and retention of new learning, which he referred to as *Cognitive Scaffolding.* This process of learning that proceeds from broader to narrower, more inclusive, and general concepts is called *progressive differentiation*. The conceptual elaboration sequence is designed, in either a topical or spiral manner. (Fig 7.6)

Theoretical elaboration sequence

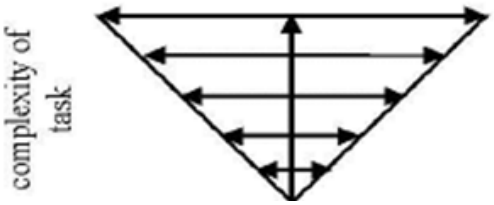
The theoretical Elaboration Sequence is intended for courses that focus on inter-related sets of principles. Hence, the sequencing strategy is based on certain principles. The principles exist on a continuum from broader, more general, and more inclusive ones to narrower, more specific, and less inclusive one. The theoretical elaboration sequence may also be done in either a topical or spiral manner.

The Simplifying Conditions Method (SCM)

For building task expertise, the simplifying conditions method is a new approach that offers guidance for analyzing, selecting, and sequencing the content ('what to learn'). In brief, it can be said that Simplified Conditions Method (SCM) is more holistic rather than fragmented and begins with the simplest version of task, and then it teaches progressively more complex versions of the task.

The SCM provides practical guidelines to make a very different kind of simple-to-complex sequence from the hierarchical sequence – one that is holistic rather than fragmented. A SCM sequence begins with the simplest version of the task, which is truly representative of the task and teaches progressively more complex versions of the task until the desired level of complexity is reached. Each version of the task is a class or group of complete real-world performances on the task. This process contrasts sharply with the hierarchical approach to sequencing, which teaches all the pre-requisites first and does not teach a complete, real-world task until the end of the sequence.

Task Analysis and Sequencing with SCM



Diversity of task

Analysis and Sequencing with *SCM* →

Simple to complex (simple task to complex task)

Task analysis and sequencing can be done simultaneously.
-the prototype can be developed rapidly.

From the very first lesson, it provides
1) The flavor of the whole task.
2) A simple but applicable skill, and
3) Enhanced motivation.

Fig. 7.7: SCM approach

Source: Reighluth and Kim (1993)

The SCM is composed of two parts: (i) Epitomizing and (ii) Elaborating. Epitomizing is the process of identifying the simplest version of the task which is a true representation of the whole task. Elaboration is the process of identifying a progressively more complex version of the task.

When we develop an elaboration sequence, we have to integrate task analysis with design and we have to ask a few questions: (i) what is the simplest version of the task that an expert has ever performed? (ii) what is the next version and so fourth. When each version is identified, its place in the sequence is simultaneously determined. In addition to this thumb rule, the relationship between the first and the second version should also be considered. Since designing the SCM sequence is more of a heuristic than a procedural process, the most important heuristics are being presented in the following headings.

7.5.1 Prepare for Analysis and Design

This is the first phase of developing a sequence. At this stage we prepare the layout of the ground work for analysis and design under the following steps:

Step 1 Establish rapport with a subject matter expert

Step 2 Identify the characteristics of the task in general

Step 3 Identify the characteristics of the learner in general

Step 4 Identify the delivery constraints of the instruction in general.

7.5.2 Identify the First Learning Episode

This is the second phase of developing a sequence. At this stage we identify the first learning episode, for which we have to consider the following steps:

- The first step is identification of simplest version of the task, which should be fairly representative of the task because it helps in identifying some other major version of task.
- The second step is organizing content. At this stage of organizing content refers to procedural task, the organizing content is done stepwise, whereas for a heuristic task the organizing content is based on principles. Hence, in the former (procedural) task a flow chart is drawn up, while in the later task (heuristic) guidelines and decision rules in a performance are explained. Sometimes, if a combination of both is needed, sub-steps, guidelines-decision or rules and explanations are identified.
- The third step is analysing the supporting content. At this stage the supporting content is analysed for the version and information, understandings, skills, meta-cognitive (higher) order thinking skills and affective qualities are identified and analyzed.
- The fourth step is to decide the size of the episode. At this stage the size of the episode should be decided. Hence, the delivery constraints, class work and homework time should be considered. Too big or too small size of an episode is not good. The age of the learners, the difficulty and abstractness of the content, the motivational value of the instruction and additional factors should be considered before deciding the size of the episode. The size of the episode can be adjusted to the target size.
- The fifth step is within the episode sequence. For this purpose pre-requisites should be taught before that content for which they are pre-requisites. The principles, causal model or process models should be taught prior to a related procedure. The coordinated concepts should be taught together.

7.5.3 Identify the Next learning Episode

This is the third phase of developing an elaboration sequence, which helps a subject matter expert (SME) in identifying the next simplest version of the task that is truly representative of the task as a whole. For identifying the next version of the task, the following steps should be followed:

- Identify all the simplifying conditions that distinguish the simplest version of the task from the more complex versions and then rank order all these versions. Different conditions of any version correspond to different sets of skills and knowledge that vary in complexity.
- The simplifying conditions are ranked and then ordering of the versions of the task from simple to complex should be done. These simplifying conditions are referred to as the 'primary simplifying conditions' (PSCs) because they are identified first, and the simplifying conditions discussed next are referred to as secondary simplifying conditions (SSCs)
- The second step of identifying the next learning episode is the identification of the next simplest and most representative version of the task or next elaboration, which is typically next rank – ordered simplifying condition. If the remaining

PSCs require more new content than can be taught in one episode, then SSCs that can be included to reduce the complexity of the new version of the task can be identified and PSC can be removed, but the SSCs must be rank ordered.

- The third step is the same as it was in phase two. At this stage, the organization of content, supporting content, size and within episode sequence is done.
- The fourth step is called 'remaining versions'. At this stage, phase III of simplifying condition (primary, secondary, and tertiary) is repeated until instructional time continues.

Check Your Progress 4

Note: i) Write your answers in the space given below
ii) Compare your answers with those given at the end of the unit.

1) What is first Learning Episode?

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2) What is the difference between topical and spiral sequencing?

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7.6 IMPLICATIONS OF ELABORATION THEORY TO INSTRUCTIONAL DESIGN

The elaboration theory, which prescribes the simple to complex sequence, allows the learner to learn at the level of complexity, which is most appropriate and meaningful to him/her at any stage in the development of the learner's knowledge.

A zoom-lens approach, in spite of its fundamental simplicity and intuitive rationale, is generally not used in instruction. The lens zoomed in to the level of complexity can be deemed appropriate for the intended population of the student because the level of complexity can pan across the entire subject matter.

Another positive point of elaboration theory is that it integrates the lost strategies of a wide variety of researches and theoretical perspectives. It prescribes the use of major strategy components, including pre-requisite sequencing, at various points during the instruction.

Elaboration theory can be helpful in educational and training contexts since instruction in both cases focuses on complex cognitive structures with a focus on understanding and cognitive tasks with a focus on skills.

Check Your Progress 5

Note: i) Write your answer in the space given below.
ii) Check your answer with the answer given at the end of this Unit.

Discuss the implications of elaboration theory.

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7.7 LET US SUM UP

In this unit, we learned about the concept of Elaboration Theory. This theory emphasis how to select and sequence content in a way that will optimize the attainment of the learning goal. We also learned about different components which should be utilized in educational and training contexts. Different components of elaboration theory are; elaboration sequence, learning per-requisite sequence, summariser synthesizer, cognitive strategy activities, and learner control. In this unit, we also discussed how an elaboration sequence can be developed and what are the different steps for developing an elaboration sequence.

7.8 CHECK YOUR PROGRESS: POSSIBLE ANSWERS

Check Your Progress 1

1) Please see section 7.3. Elaboration theory as a macro-level theory prescribes methods that deal with many related ideas and how to sequence these ideas. The macro-level is made up four areas such as selection; sequencing; synthesizing and memorizing of subject matter content.

2) Please see section 7.3. Explain studying a subject matter through the elaboration theory, it is similar to studying a picture through a zoom lens of a camera where the zoom lens allows a person to see the major parts of the picture and the major relationship among these parts. While zooming in allows one to see the major sub-parts of a part and zooming out gives a view of context and review.

Check Your Progress 2

See section 7.4. Different components of elaboration theory are:

i) An elaboration sequence
ii) Learning Pre-requisite sequence
iii) Summarizer
iv) Synthesizer
v) Cognitive strategy Activator

Check Your Progress 3

1) Please see sub-section 7.4.6. The concept of learner control refers to the freedom of the learner for selection and sequencing of content explain the idea of (i) content control, (ii) display control and (iii) conscious cognitive control.

2) A summarizer is a strategy component that reviews systematically the learned material to minimize forgetting, while a synthesizer is a strategy component for relating and integrating ideas. .

Check Your Progress 4

1) Please see sub-section 7.5.2. Please write the steps of the first learning episode.

2) i) Topical sequencing: Here a topic is taught to whatever depth of understanding is required before moving to next.

   ii) Spiral sequencing: Here the learner learns the basics of one topic, then another, then another.

Check Your Progress 5

Please see section 7.6 Please write about the relationship between the ideas of elaboration theory with instructional design. For example how the simple to complex sequence allows the learner to learn at the level of complexity, the zoom lens can help in better understanding of complex subjects, pre-requisite sequencing and its effect on better understanding of subjects by learners.

UNIT 8 COGNITIVE LOAD THEORY (CLT) AND COGNITIVE FLEXIBILITY THEORY (CFT)

Structure

8.1 INTRODUCTION

Cognitive Science, which deals with the psychological processes of learning, memory, and problem solving, has made major contributions to education and training, and on the effectiveness and efficiency of instructional strategies. In the previous unit, you have studied Elaboration Theory, which prescribes the use of pre-requisite sequences, the systematic use of review and synthesis. In this unit, we will discuss the cognitive load theory and cognitive flexibility theory.

Cognitive Load Theory (CLT) describes learning structures in terms of an information processing system involving long term memory, thereby associating indirectly with working memory. To understand this, first, we have to know what working memory is. Working memory performs the intellectual tasks associated with consciousness. However, it is extremely limited in both capacity and duration. The uniqueness of working memory is that information may only be stored in the long-term memory after first being attended to, and processed by, working memory. Long-term memory effectively stores all of our knowledge and skills on a permanent basis. The limitations of working memory, under some conditions, impede learning. Cognitive load theory came into the field of education in the early 1980s. The basic principle of cognitive load theory is that the quality of instructional design is

directly proportional to the consideration given to the role and limitations of the working memory. Hence, cognitive load theory has been used to develop several instructional strategies, which have been demonstrated empirically to be superior to those used conventionally.

This Unit outlines some of the basic principles of cognitive load theory. For better understanding, examples of the instructional design strategies generated by cognitive load theory are also provided.

This unit from section 8.8 onwards focus on Cognitive flexibility theory (CFT).

8.2 LEARNING OUTCOMES

After going through this Unit, you should be able to:

- establish a relationship between instructional psychology and instructional design;
- explain salient features of cognitive load theory;
- identify predictions for student learning;
- narrate the significance of cognitive flexibility theory towards instructional design; and
- suggest ways to implement Cognitive Load Theory (CLT) and Cognitive Flexibility Theory (CFT) in distance learning.

8.3 THE CHANGING TREND BETWEEN INSTRUCTIONAL PSYCHOLOGY AND INSTRUCTIONAL DESIGN

As a distance teacher, you must be interested in learning or motivation problems of your students and how to solve such problems. You may also have thought of some of the following questions:

- Why are some subjects difficult for learners to understand?
- Why are some of the students more motivated than others?
- Why do we forget to apply our knowledge learned in school/college to real-life problems?
- Why do all students not secure the same grade in the same course?

You can answer these questions regarding cognitive development in the instructional context.

What is cognitive development?

Cognitive development is the development of mental processes, like thinking, learning, remembering, problem-solving, etc. These are different from other psychological constructs like emotions, friendship, or personality traits. These cognitive processes change with age or experience (Klahr & MacWhinney, 1998). You would agree to the fact that no one single instructional technique can work well for all students at all grade levels. Certain instructional techniques are more beneficial to some students than others (Pressley, et al., 1994; Snow, 1994). Stofflet (1994) advised that we must not teach a topic to undergraduate students in the same way as we would teach it to postgraduate students.

Therefore, it is pertinent here that the instruction has to be designed based on the needs of different groups of students. An appropriate instructional design helps a teacher to become more flexible and enables the teacher to help in problem-solving.

What is Instructional Psychology?

To understand the concept of instructional psychology, you need to understand the learning theories. We have discussed these theories earlier in units 2, 3, and 4 of Block-1. Learning theories have evolved from behaviorism (where objectives and reinforcements techniques are used to focus the learning effort) to cognitivism (where information processing occurs within the brain based on inputs) and to constructivism (where a learner creates his or her own meaning). (Please refer to Block-1 for Theories of Learning.) This meaning further depends on the learner's interaction with people, presence at a place, or adoption of a thing in terms of social context. The theories have significant value in instructional psychology.

Instructional psychology is usually referred to as the theory and principles derived from the application of psychological principles in the improvement of instruction, or that result when psychologists conduct research on various forms of instruction.

What is Instructional Design?

We have discussed the concept of instructional design in Block 2, Unit 5. Here, we will focus on the changing trend between the two concepts.

What is instructional design? How it is applicable to instructional psychology?

Smith and Ragan (1993) defined Instructional Design as the systematic process of translating general principles of learning and instruction into plans for instructional materials and learning.

Important components of instructional design include instructional materials, learning activities and an assessment of instruction and learning (Gentry, 1994).

Global trends show that distance education and training are being increasingly used in campus mode learning settings. If we speak of distance education, the nature of distance learners, gender, cultures, self-concept, etc., need to be taken into consideration while thinking of instructional design. There is a need to know the learners, offer them orientation, design for differences in learning styles, etc.

Since distance learners are adult learners, therefore, distance educators need to look more closely at their use of behavioral and cognitive approaches to instructional design (Olgren, 1998).

Deubel (2000) found that behaviorism plays a significant role in instructional design. Olgren (1998) considered a constructivist perspective as a base for learning strategy. This idea was not supported by Sfard (1998) who indicated that we may not opt for only one metaphor for learning as "dictatorship of a single metaphor, like a dictatorship of a single ideology, may lead to theories that serve the interests of certain groups to the disadvantage of others". Sfard (1998) considered two factors important in learning: acquisition and participation. Learner participation is achieved through constructivism and skill building is achieved through acquisition. Deubel (2000) commented that the idea that new knowledge germinates in old knowledge has been promoted by all the theoreticians of intellectual development, from Piaget and Vygotsky to contemporary cognitive scientists.

Therefore, the above discussion indicates that there has been change in the approaches to learning theories towards the practice of instructional design. Although it seems that cognitive theory is the dominant theory in instructional design, the instructional strategies adopted by behaviorists are also used by cognitivists. Behaviorists prefer learners to decide a starting point for instruction, while cognitivists expect the learner to decide their predisposition to learning.

If we take the instructional design from a behaviorist/cognitivist point of view, the instructional designer analyses the content and learning environment, and then formulates the goals. The main emphasis is on identifying what is significant for the learner to understand and then to adopt an instructional strategy to create knowledge.

The constructivist approach considers that instruction is more facilitative than prescriptive in nature. In this strategy, the content is not pre-decided, and the learner selects the path to progress in that content. This strategy requires a kind of self-evaluation of the learner.

Check Your Progress 1

Note: i) Write your answer in the space given below.
ii) Check your answer with the answer given at the end of this Unit.

Describe the changing trend in instructional psychology and instructional design.

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8.4 COGNITIVE TEACHING MODEL

The Cognitive Approach is the basic approach to the learning process. By studying the structures of thinking and remembering, the cognitive approach to learning tries to understand an individual's thought processes. According to Driscoll (2001), the cognitive approach refers to all the processes by which sensory input is transformed, reduced, elaborated, stored, recovered, and used. This includes hypothetical stages or aspects such as sensation, perception, imagery, retention, recall, problem-solving, and thinking.

The basic Cognitive Information Processing model is concerned with mental operations, related to how an individual perceives and remembers events and information as to how it was explained initially to the learner. Thus, the cognitive theory states that learning is a process that is dictated by the students' previous experiences, and how the information is presented to the student.

The following are the *implications* for designing instruction in the cognitive teaching model:

- The students' informal knowledge is the base. This is because new material is learned with ease when it is related to what is known to the learner initially.
- The students' current mindset should be identified.
- The errors committed by the student, and the misconceptions prevailing in the student's mind should be viewed as a source of information to know about their mental makeup.
- Since think-aloud activities help to uncover current models, they should be used.
- Hands-on experience should be used, besides explicitly teaching problem-solving strategies. This is because when students learn from observation, certain minute details may be missed, but they remember it better when they do a task/activity themselves.
- Processes, structures, and decisions develop conceptual understanding and this is a focus area.

The major teaching approach under the cognitive approach includes learning, problem-solving, and discovery learning. Although they are commonly done inside the classroom, these are also applied while designing distance learning materials.

Check Your Progress 2

Note: i) Write your answer in the space given below.
ii) Check your answer with the answer given at the end of this Unit.

Discuss the implications of Cognitive Teaching Model.

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8.4.1 Cognitive Strategies

Cognitive strategies are very important for the development of intellectual skills when it comes to learning and thinking. The cognitive theories of learning explain cognitive strategy as a control process (an internal process) by which a learner selects and modifies his ways of attending, learning, remembering, and thinking and has also established the relevance and usefulness of cognitive strategies in problem solving. Let us discuss the various cognitive strategies.

Weinstein and Mayer (1986) identified the following cognitive strategies:

- Rehearsal Strategies
- Elaboration Strategies
- Organizing Strategies
- Comprehensive Monitoring Strategies
- Affective Strategies

Rehearsal strategies

You must have heard the famous saying that "Practice makes a man perfect". The rehearsal strategy allows a learner to carry out the practice of a skill or activity, like knowing through repetitions. If the content being mastered is complex in nature, then the learners underline main ideas or copy important text during rehearsal.

Elaboration strategies

In this type of strategy, the learner associates the item to be learned with other easily available material. For example, to learn words of a foreign language, the learner can associate those words to a mental image of a similar word in his/her mother tongue. Other activities, which are undertaken in this strategy are paraphrasing, summarizing, note-taking, and generating questions with answers.

Organizing strategies

In this strategy, the learner arranges the material to be learned in a particular framework, for example, if you want to learn a set of words, you may arrange them in a meaningful category for easy remembrance. Sometimes learners make an outline of main ideas

and generate new organisation. In this strategy, the relation among ideas is important, like when we make a comparison of different concepts, we are using some relation among different parameters.

Comprehensive monitoring strategies

Brown (1978) called this strategy as a metacognitive strategy as it "pertains to the student's capability of setting goals for learning, estimating the success with which the goals are being met, and selecting alternative strategies to meet the goals". Golinkoff (1976) noticed the element of monitoring in this strategy, which is conspicuous in reading for understanding. Meichenbaum and Asarnow (1979) suggested that the students may develop statements and questions to be used in guiding and controlling their performance.

Affective strategies

Affective strategies are very useful when the learners want to focus on an item and keep their attention and anxiety, controlling and managing time effectively. Dansereau (1985) and McCombs (1982) recommended that the students must be made aware of their operation and how to practice such affective qualities.

Assessing the effectiveness of cognitive strategies

Assessing the effectiveness of cognitive strategies through direct means can be a difficult exercise. However, we can make our judgements by employing other intellectual skills. Ericsson and Simon (1980) suggested the way by asking learners to "think aloud" while they are learning, remembering, or solving problems. The performance of cognitive strategies depends upon internal conditions and external conditions.

Internal conditions

Internal conditions denote the prior knowledge (intellectual skills and verbal information) associated with content to be mastered.

External conditions

We can explain the strategies to the students either by verbal communications or through demonstration. Learning through discovery is also an external factor. This external factor depends on the facilities or opportunities for practice provided to the students.

Check Your Progress 3

Note: i) Write your answer in the space given below.
ii) Check your answer with the answer given at the end of this Unit.

Explain briefly the various cognitive strategies.

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8.4.2 Pre-requisites for Cognitive Strategies

An understanding of the prerequisites for cognitive strategies of learning has its implications for the effective development of mental abilities (like thinking, remembering, deducing) of students. Suppose a learner wishes to remember a list of items. An effective cognitive strategy that this learner can adopt is to create different mental images for each item and link them. To accomplish this, the learner needs to have the pre-requisite of "ability to have visual images".

Table 8.1: Essential and Supportive Prerequisites for Five Kinds of Learning Outcomes

Type of learning outcomes	*Essential prerequisites*	*Supportive prerequisites*
Intellectual Skill	Simpler component intellectual skills (rules, concepts, discriminations)	Attitudes, cognitive strategies, verbal information
Cognitive Strategies	Specific intellectual skills	Intellectual skills, verbal information, attitudes
Verbal Information	Meaningfully organized sets of information	Language skills, cognitive strategies, attitudes
Attitudes	Intellectual skills (sometimes) Verbal information (sometimes)	Other attitudes, verbal information
Motor Skills	Part skills (sometimes) Procedural rules (sometimes)	Attitudes

Source: Gagne, Briggs and Wager (1988)

Let us consider another example. Suppose a learner wants to solve a complex mathematical problem. She or he can break this problem into parts and try solving individual parts first and then combining them. This strategy involves the pre-requisite of the 'ability to divide a verbally described situation into parts'.

An important factor here is the level of the innate ability of the learner (developed through maturation) and how much they have learned. Piaget (1970) gave more significance to maturation, whereas Gagne (1985) considered cognitive strategies as generalizations from learned intellectual skills.

Check Your Progress 4

Note: i) Write your answer in the space given below.
ii) Check your answer with the answer given at the end of this Unit.

Explain the various pre-requisites of cognitive strategies.

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8.5 THE ROLE OF TEACHING MODELS (COGNITION AND LEARNER ACHIEVEMENT)

During our lifetime we keep learning. This learning includes learning of motor skills (like eating with a fork, tying shoe laces, writing letters of alphabets in childhood), acquire information (like adding new words to our vocabulary), make patterns and relationships among different pieces of knowledge, etc.

Besides, learning in your mother tongue creates less pressure than studying in a foreign language. This is because while studying in a foreign language, the brain must work to translate the language besides trying to grasp the new information.

Cognition also facilitates in understanding, how prior to the occurrence of information loss, individual units of information can be retained in short term memory. Therefore, teaching models must be applied in such a way that helps students to retain the information, which has been presented to them in the classroom permanent in their memory. This can be achieved: (a) by maximizing the opportunities the learners have to practice the recently learned content, and: (b) encouraging elaborative encoding of the information and knowledge (for example, by pondering over why, how, when, etc., of the content). It has been found that memory can be improved when such teaching environments are created, which leads to higher emotional responses on the part of learners.

You must have noticed that there are students in counselling sessions who have the skill to do well (knowledge of how to do a thing or what is that concept), but they lack the 'will' to do that. These students are called under achievers. There are cases too where the students were not skilled to that extent, but by trying hard, they are able to achieve a lot. These students are known as over achievers. We need to make an assessment of the situations when a student performs poorly in a class. Is it due to a lack of motivation? Motivation is generally described as a construct denoting initiation, direction, intensity, and persistence of an individual's behaviour in a particular situation. These constructs can be grouped under three categories. They are:

a) Goal related constructs,
b) Knowledge related constructs, and
c) Metacognitive constructs.

Goal related constructs deal with the reason why students do what they do. Knowledge related constructs deal with behaviours where we study what they do. Metacognitive constructs deal with activities of monitoring and appraisal.

The counsellors have a significant role in fostering the ability to reflect in the students and helping them to understand the process of learning. Therefore, teaching models emphasize on activities such as providing enough time for the students to ponder over a problem and come out with an answer for that and then rewarding their effort.

Another implication of the teaching model in cognition and learner achievement is comprehending the information. When content is presented, it is advisable to have the student classify things into categories, arrange things along with some parameters, make hypotheses, draw inferences, analyze things into their components, and solve problems. These cognitive processes can apply to any subject matter, but the more important factor here is that the student knows and comprehends the fundamental information first.

When tests are created, there should be adequate cues in questions to maximize the chances that the students will be able to reclaim the information. This can be accomplished by arranging questions in the same order that the material was presented in the classroom. This helps students in using their episodic cues (like they can recall what they wrote in their notes while listening to the lecture in the class or what things happened in the class on a particular day). Providing examples similar to those presented during teaching the content would also be beneficial.

8.6 TYPES OF COGNITIVE LOAD THEORY

Cognitive Load Theory (CLT) originated in the 1980s, and afterwards a lot of research has gone into this to provide a framework to look into the cognitive processes and instructional design (Paas, Renkl , & Sweller, 2003). According to Sweller, van Merriënboer, and Paas, (1998), "Cognitive load theory is designed to provide guidelines intended to assist in the presentation of information in a manner that encourages learner activities that optimize intellectual performance".

In 1956, G. A. Miller gave the concept of working memory capacity and suggested that human beings are only able to hold seven plus or minus two digits of information in their short term memory. As a beginner, a learner associates with things in the environment and sees patterns in the world around him/her, which is referred to as 'schema construction' by Simon and Chase (1973). This gives the concept of cognitive load. Cognitive load refers to the total amount of mental activity imposed on working memory at an instance in time.

Miller (1956) further suggested that the capacity limit of the working memory is reduced if the pieces of incoming information are related to each other, and need to be stored in memory till the understanding about them happens. This leads to high interactivity. Further to this discussion, it has been established that the limit of working memory can be extended through recoding or chunking. Recoding means that a learner uses the prior knowledge of the solution steps (which are isolating, grouping, simplifying, and checking), and then organises the incoming information into this schema. What is schema? A schema is an organised pattern behaviour which the learner develops when s/he is engaged in an activity. It connects the individual with the environment. The schema formation is the basis of the cognitive learning theory. This schema is processed in the working memory as one unit, so that memory space is freed for other information.

Cognitive load theory states that learning will be maximized by ensuring the learners' working memory to be free to attend solely to encoding to-be-learned information. The cognitive load theory is based on the following tenets of cognitive learning:

- The short-term memory (working memory) is limited in capacity to about seven informational units.
- Long-term memory is unlimited in capacity and is where all the information and knowledge is stored.
- Knowledge is stored in long-term memory as schemas or schemata.
- Schemas, no matter how large or how complex, are treated as a single entity in working memory.
- Schemas can become automated.

Cognitive load theory differentiates between three types of cognitive load, namely:

- Intrinsic cognitive load,
- Extraneous cognitive load, and
- Germane cognitive load.

Let us now discuss in detail what these terms are.

8.6.1 Intrinsic Cognitive Load

Intrinsic load is the load on memory needed at the time of doing the current task. It denotes the quantum of the working memory being utilised by the interactivity of the units of tasks bring processed. These different tasks differ in their interactivity, and thus, the intrinsic cognitive load will also vary. This cannot be manipulated by instructional activities. For example, what you have studied in Class Four English would definitely be less in content to what you have studied in your Class Tenth English course.

In other words, the intrinsic load is the load on memory required by the thinking task at hand. The intrinsic load serves to quantify how much of the working memory is used, due to the interaction of the units of information being processed in the mind of the human being.

8.6.2 Extraneous Cognitive Load

Extraneous cognitive load can be represented as a teacher's presentation, external distractions, textbook instructional format, etc. These variables use a large amount of working memory, and little is left for the learning task at hand. Thus, the extraneous cognitive load does not contribute to the learning. The significance of the extraneous cognitive load increases when the intrinsic cognitive load is high. When the intrinsic cognitive load is less, the level of extraneous cognitive load would also be low, the reason being that the total cognitive load may not exceed the working memory capacity. Thus, the extraneous cognitive load can be influenced by the instructional designer.

8.6.3 Germane Cognitive Load

When a learner learns something new schema is formed and is added to the working memory capacity. Thus, the working memory needs to process this new learning into the next higher level of advanced schema. This is known as the germane cognitive load. Like extraneous cognitive load, the germane cognitive load can also be influenced by the instructional designer.

Intrinsic, extraneous, and germane cognitive loads are additive in that, together, the total load cannot exceed the working memory resources available if learning is to occur. The relations between the three forms of cognitive load can be shown as below:

Intrinsic + Germane + Extraneous = Total Cognitive Load

The following facts need to be kept in mind while discussing the cognitive load theory:

1) Individuals differ in their information processing capacity.
2) Irrespective of the task in question or the processes an individual uses in solving any given task, each individual has a fixed capacity for processing information. This fact is applicable for tasks varying from remembering simple words to performing advanced calculations.
3) It is worthwhile to identify the information processing capacity of individuals. This is useful in adapting instruction and understanding the behavior of the learner.

Cognitive load theory has implications for instructional designers for the following reasons:

- It has its implications for the way the instructional material is presented to students.

- Learning can be enhanced by redesigning instructional materials to reduce the levels of extraneous cognitive load.
- Controlling the elements of to-be-learned information and their interactivity with one another would exhibit better results.
- Instructional designers can control the conditions of learning within an environment, or more generally, within most instructional materials.
- Instructional designers can decrease the extraneous cognitive load during learning and increase the germane (schema related) cognitive load.
- Cognitive load theory stresses the need to minimise the total cognitive load, and maximise cognitive resources available to be utilised in the learning process. In other words, if for some reason, cognitive load increases rather than decreases, then learning will be inhibited.
- Cognitive load theory facilitates the development of strategies and techniques that result in both reduced training times and enhanced performance. This is of vital importance to the education and training industries.
- Cognitive load theory has applicability to subjects that focus on problem-solving skills such as Mathematics, Physics, Chemistry, and Computer Science, and hence are inbuilt in the instructional process of these subjects.

Check Your Progress 5

Note: i) Write your answer in the space given below.
ii) Check your answer with the answer given at the end of this Unit.

What do you understand by the term Cognitive Load Theory?

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8.7 PREDICTIONS FOR STUDENT LEARNING

When you ask your students to learn something, exactly what do you think, how, and what the student would be learning? Do you expect an improvement in student behaviour or a change in some other personality traits?

Learning is a continuous process. We learn about new words, associations, relationships, etc. Did you ever think of what cognitive processes are involved in learning? As a teacher, how can we facilitate learning in students? What are various factors which affect the process of learning among the students?

As learning is said to be a relatively permanent change in behaviour due to experience, therefore, educators focus on how students' behaviour changes over time. They also pay attention to the environmental conditions that bring such changes about. But note that all changes in behaviour cannot be termed as learning. Some changes are short-lived and unrelated to any specific experience. For example, the feeling of fatigue or stomach ache is temporary, and once this is over, we come back to our normal state of being. Therefore, as teachers, we need to focus on the processes involved in learning new knowledge and skills. The mental processes like memory,

attention, concept learning, problem-solving and reasoning, etc., must be given due attention. Let us see some factors that help a teacher predict student learning. These factors may be in the form of:

- simple content,
- high levels of interactions, and
- instructional prescriptions.

8.7.1 Simple Content

During the learning phase, individuals construct knowledge from their experience, rather than simply cramming it from the material presented to them. Constructive processes during the learning phase have an impact on short-term memory and long-term memory storage and retrieval. When a student learns a thing, he or she organises it in different ways. The students may make a mental group on the categorisation of objects, concepts, or events. They are expected to understand a concept when they can explain it in their own words, and identify the negative and positive instances associated with that event or concept.

The four processes involved in learning content are:

- memory
- storage
- encoding
- retrieval

Memory is the ability of an individual to retain or store the learned knowledge or skill over a period of time. The storage is defined as an acquisition of new knowledge, and is the process of putting what is learned into memory. Encoding is the way we store information, which may not be necessary when we received it. The students may change or encode it, as per their learning ability, so that they can make their own meanings and interpretations of that knowledge. When we need to use the stored knowledge, we retrieve it from our memory. It is a sort of finding information in memory.

Thus, the students must be able to use all four abilities for effective learning. This can be ascertained when the content is simple in nature and facilitates these four processes. Most people can attend to only a very small amount of information at any one time, as attention has a limited capacity. Therefore, when the content is simple, it can be stored easily, and later on, when required this stored information is moved into the working memory.

8.7.2 Instructional Prescriptions

As we said in the previous section, we must remember that the students may not necessarily learn the content the way it is presented to them. The students will interpret the content material in their own way. Therefore, it is a good strategy that we may ask questions, encourage dialogue, and when students reply, we must listen to their ideas and explanations carefully.

We need to remember that students' prior experiences play a great role in their ability to understand and learn the content matter.

The following instructional prescriptions are recommended:

- Try to present the content matter in more than one way in the classroom.
- Prove to the students that the new content they are learning is related to their previous knowledge.

- The content matter needs to be presented in an organised manner.
- The students may be encouraged to form visual images of the content they are studying. This enhances memory.
- We must proceed from known to unknown. The instruction must begin with the level consistent with the students' existing knowledge base.

Check Your Progress 6

Note: i) Write your answer in the space given below.
ii) Check your answer with the answer given at the end of this Unit.

Explain the various factors that help a teacher in predicting student learning

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8.8 THE COGNITIVE FLEXIBILITY THEORY (CFT)

Cognitive Flexibility Theory (CFT) is a conceptual model for designing learning environments based on cognitive learning theory. This theory focuses on learning in complex and ill-structured domains, which symbolize real life. According to Spiro and Jehng (1990), cognitive flexibility is defined as "the ability to adaptively re-assemble diverse elements of knowledge to fit the particular needs of a given understanding or problem-solving situation".

This theory represents an integration of learning, mental representation, and instruction. The instruction designed using Cognitive Flexibility Theory prevents over-simplifying instruction by providing:

- Practical oriented real life situation cases,
- Multiple representations of the content in order to enhance transfer, and
- Facilitates the knowledge construction by learners.

The main principles of the CFT (Spiro, Feltovich, Jacobson, & Coulson, 1995) are as follows:

- Over-simplification of instruction should be avoided.
- Subject content must be presented in multiple ways to enhance learning.
- Case-based instruction should be given more importance. This is more beneficial than instruction based on a single example or case.
- Real-world examples and phenomena serve better for knowledge construction.
- Purpose of instruction should be the construction of knowledge and not the transmission of knowledge.
- Different constructs of knowledge must be interrelated instead of being isolated.
- This theory has been found effective in advanced knowledge creation.

8.8.1 Constructivism and Cognitive Flexibility Theory

The cognitive flexibility theory and constructivism are related to each other in how they focus on the ways the learners construct knowledge. The knowledge of a learner is not based merely on a collection of isolated pieces of information. It also depends on

accumulated information, and also, how the learners construct their knowledge based on that. Therefore, for cognitive flexibility theory, constructivism suggests that the students should be motivated to construct their own knowledge. Instruction should be designed to encourage the learners to imagine beyond the information presented to them.

8.8.2 Cognitive Flexible Hypertext

Before we close, it would be relevant to know the cognitive flexibility theory in relation to hypertext/hypermedia. Hypertext refers to "computer-based texts that are read in a non-linear fashion and that are organized on multiple dimensions.

This concept has great significance for the multimedia content. Multimedia content is comprised of an integration of text, audio, video, and images. The cognitive flexible hypertext highlights that when such content is presented to the learners, they view it in different ways, and thus make, their own understandings. Therefore, this approach has been found quite suitable for advanced learning, whereby the learners are enabled to apply, evaluate, and synthesize their knowledge.

Check Your Progress 7

Note: i) Write your answer in the space given below.

ii) Check your answer with the answer given at the end of this Unit.

Discuss the main principles of Cognitive Flexible Theory.

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8.9 LET US SUM UP

As a learner, you would have experienced that there is a changing trend between instructional psychology and instructional design. Layout, content and presentation are given the utmost importance so that it attracts the learner, and makes him or her learn amidst the various commitments. In this unit, we have developed an understanding about the Cognitive Teaching Model, the Role of Teaching Models, Cognitive Load Theory, and the Cognitive Flexibility Theory. The various Cognitive strategies are: rehearsal, elaboration, organizing, comprehensive mentoring, and affective strategies. The cognitive load theory focuses on how to present instruction and material to students, especially in the case of subjects such as Mathematics, Physics, Chemistry etc. that focus on problem-solving skills

8.10 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

Please see section 8.3. Explain the changes taking place in use of cognitive theory in instructional design, and also how the instructional strategies of behaviorists are also used by cognitivists.

Check Your Progress 2

Please see section 8.4 on cognitive teaching model.

Check Your Progress 3

Please see sub-section 8.4.1 and explain the cognitive strategies adopted by Weinstein and Mayer i.e. Rehearsal Strategies, Elaboration Strategies, Organizing Strategies, Comprehensive Monitoring Strategies, Affective Strategies

Check Your Progress 4

Please see sub-section 8.4.1 and explain the cognitive strategies adopted by Weinstein and Mayer.

Check Your Progress 5

Please read section 8.6 carefully and write about CLT in your own words.

Check Your Progress 6

Please read section 8.7 and explain simple content, high levels of interactions, instructional prescriptions.

Check Your Progress 7

Please read section 8.8 and write about Cognitive Flexibility Theory (CFT).

UNIT 9 THEORY OF MULTIPLE INTELLIGENCES

Structure

9.1 INTRODUCTION

Do you know what intelligence is? Intelligence is the ability to learn or understand or to deal with new situations. (Webster's New Collegiate Dictionary, 1973). Our intelligence is measured by IQ (intelligence quotient) tests.

Intelligence is the capacity of an individual to deal with situations. Intelligence Quotient (IQ) is the simple way to describe intelligence by assigning it a number that represents the ratio of mental to chronological age, multiplied by 100. Average IQ is, therefore, 100 and is based on a comparison between an individual's performance, comparable to others.

Wagner and Sternberg (1984) reported that there are three different views of intelligence. According to them, the first view is the 'psychometric view'. Psychometrics (the most common approach to understand intelligence) refers to the measurement of psychological functions. Hence, the psychometric view of intelligence is that, which is based on a measurement approach. Wagner and Sternberg (1984) suggested a second view of the 'Piaget view'. Piaget's view treats intelligence as an active process, involving progressive adaptation through the interplay of assimilation and accommodation. Here, the outcomes of intelligent activity are reflected in a cognitive structure. Piaget's developmental theory treats change as a prime factor, like with change in age, the cognitive structure of an individual changes. The third view of intelligence is referred to as the 'information processing view'. This view is more qualitative than quantitative. In this view, intelligence is defined in terms of processes rather than to measure its products.

There are various theories of intelligence. In this unit, we shall study intelligence and the Theory of Multiple Intelligences, which was developed by Howard Gardner (1985). Gardner was a Professor at Harvard University. He believed that there are at least eight distinct intelligences possessed by all people and that every person has developed some intelligences more than others. This is evident from the fact that some people learn a concept more quickly than others. You could have experienced that sometimes, however hard you may try, you are not able to grasp a certain matter. The theory of multiple intelligences explains the reason.

9.2 LEARNING OUTCOMES

After going through this unit, you should be able to:

- define intelligence;
- explain the meaning of multiple intelligences;
- narrate the goal of multiple intelligences;
- describe various components of Gardner's Theory of Multiple Intelligences; and
- explain the implications of Multiple Intelligences Theory for Instructional Design.

9.3 WHAT IS INTELLIGENCE?

The field of the study of intelligence has grown a great deal as human intelligence is constantly evolving and dynamic. Contributions by psychologists like Coles (1997), Gardner (1993), Goleman (1995), Hass (1998), Hough (2001), Kruger and Dunning (1999), and Mayer and Salovey (1993), etc., have contributed significantly to this field.

Let us have a look at some of the definitions of intelligence:

- "The global and aggregate capacity of an individual to think rationally, to act purposefully, and to deal effectively with his environment" (Wechsler, 1958, p. 7).
- Hebb (1966) defined, "Intelligence A: The innate potential for cognitive development". He defined "Intelligence B: A general or average level of development of ability to perceive, to learn, to solve problems, to think, to adapt" (p. 332).
- West and MacArthur (1964) defined intelligence as "the present potential of an individual for future development of intelligent behaviour, assuming optimum future treatment adapted to bring out that potential" (p.18).

In the area of human intelligence, the work of Robert J. Sternberg is considered among the outstanding works. In 1985, he propounded the Triarchic Theory of Human Intelligence (Sternberg, 1985), and related the concept of human ability and success. He suggested that a successful intelligence may be treated as a set of mental abilities used to achieve one's goals in life, given a socio-cultural context, through adaptation to, selection of, and shaping of environments.

There are several dimensions of intelligence. They are:

- Successful intelligence
- Practical Intelligence
- Moral Intelligence
- Social Intelligence
- Emotional Intelligence.

Successful intelligence

Sternberg (1998) suggested that for successful intelligence there are three components, that are, although distinct, yet broadly interrelated. These are: analytical, creative, and practical thinking.

Practical intelligence

Practical intelligence is the ability to respond well in a situation, to be able to determine how to achieve goals, to display awareness to the world around you, and to display interest in the world at large (Sternberg, 1990; Sternberg, et al., 2000; Wagner, 2000).

Moral intelligence

When a person is able to decide between what is right and what is wrong, it is called Moral Intelligence. Moral intelligence lets us make decisions which are not only beneficial to us, but also to others who are around us (Coles, 1997; Hass, 1998).

Social intelligence

Social intelligence is given significant attention in the literature on management and organizational psychology (e.g., Hough, 2001; Riggio, Murphy, & Pirozzolo, 2002). Here, a person develops an ability to understand other people: what motivates them, how they work, how to work cooperatively with them. This intelligence is very much beneficial to those who have to deal with groups or masses, and thus an understanding of others helps them achieve their goals effectively. You must have noticed how a salesperson sells his product by making one realize that his product is essential to him. Similarly the politicians and religious leaders possess a high degree of social intelligence and motivate the people through their impressive skills.

Emotional intelligence

Mayer and Salovey (1993) defined emotional intelligence as a type of social intelligence that involves the ability to monitor one's own and others' emotions, to discriminate among them, and to use the information to guide one's thinking and actions (p. 433). According to Goleman (1995), "Emotional intelligence, the skills that help people harmonize, should become increasingly valued as a workplace asset in the years to come" (p. 160).

Salovey and Mayer (1990) categorized emotional intelligence into five domains:

- ***Self-awareness*:** Observing yourself and recognizing a feeling as it happens.
- ***Managing emotions*:** Handling feelings so that they are appropriate; realizing what is behind a feeling; finding ways to handle fears and anxieties, anger, and sadness.
- ***Motivating oneself*:** Channeling emotions in the service of a goal; emotional self control; delaying gratification and stifling impulses.
- ***Empathy*:** Sensitivity to others' feelings and concerns and taking their perspective; appreciating the differences in how people feel about things.
- ***Handling relationships*:** Managing emotions in others; social competence and social skills.

Based on the above discussion, we may say that intelligence is an innate ability with the help of which you can solve the problems by utilizing the resources.

Check Your Progress 1

Note: i) Write your answer in the space given below.
ii) Check your answer with the answer given at the end of this Unit.

Explain the various dimensions of intelligence.

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9.4 MULTIPLE INTELLIGENCE: AN OVERVIEW

The traditional theories of intelligence are related to the learning ability of an individual. These state that a more intelligent person learns anything quicker than a less intelligent person. Intelligence has been considered different from what an individual has actually learned. To measure intelligence, Alfred Binet developed a method to identify such students who are unlikely to benefit from traditional school instruction and thus would need special arrangements. Thus, Binet developed a test to measure general knowledge, vocabulary, perception, memory, and abstract thought. This test is known as the Binet's Intelligence Test and the scores on this intelligence test are measured as "Intelligence Quotient" (IQ).

In 1983, an American psychologist named Howard Gardner provided a new definition of intelligence. He suggested that intelligence was the ability to do any activity well. He believed that there are eight different abilities (or intelligences), which are relatively independent of one another. The students may be quite intelligent in one ability or the other. Someone is better in vocabulary, someone is better in dancing or mathematical calculations etc. To support the theory of multiple intelligences, Gardner, presented examples of people who were skilled in one area (for example, composing music) but had average ability in other area like knowledge of flora and fauna.

These intelligence tests were designed to measure mostly the language and mathematical ability of the students. They were not designed to measure other abilities of the individual like singing or dancing or playing a musical instrument or classifying natural forms, etc.

We have discussed Gardner's theory of multiple intelligences in section 9.5.

9.5 GARDNER'S THEORY OF MULTIPLE INTELLIGENCES

Dr. Howard Gardner defines intelligence as "an ability to solve a problem or fashion, a product that is valued in one or more cultural settings". He suggested that intelligence is not fixed and that it can be learned as a set of abilities and skills to apply to any situation at any given time within any given context. When you master all of your intelligences, then you really use the full potential of your brainpower. Gardner reported that a person can be intelligent in many ways. He further found that the traditional intelligence tests are not adequate to measure all the ways to become intelligent. According to Gardner, there can be more than the eight ways to be intelligent, i.e., you can be intelligent in terms of (1) linguistic (words); (2) logical-mathematical (numbers); (3) spatial (pictures); (4) musical (musical/rhythmic); (5) bodily-kinesthetic (movement); (6) intrapersonal (self); (7) interpersonal (people); (8) naturalist (plants and animals).

The eight intelligences of Howard Gardner's theory are described below:

1) **Visual-Spatial:** The ability to perceive the visual-spatial world accurately and represent this world internally in one's mind. We can see this type of ability in architects, artists, sculptors, cartographers, anatomists, and scouts.

2) **Bodily-kinesthetic:** The ability to use one' body or body parts such as hands and fingers to solve problems and express ideas. We can see this type of ability in athletes, dancers, actors, and mimes.

3) **Musical Rhythmic:** The ability to think in music, hear music almost continuously, and recognize musical patterns, remember them, and transform them. We can see this type of ability in musical performers, people who love to play musical instruments or sing, and people who enjoy listening to music.

4) **Linguistic:** The ability to use language effectively, either in oral or written from, to express ideas to others. We can see this type of ability in writers, poets, storytellers, lawyers, editors, journalists, and (hopefully) college textbook authors.

5) **Logical-Mathematical:** The ability to use numbers and operations mathematically and to reason logically. We can see this type of ability in mathematicians, accountants, statisticians, scientists, and computer programmers.

6) **Intrapersonal:** The ability to understand oneself, know who oneself is, know one's own strengths and limitations, and to act in accordance with this self knowledge. We can see this type of ability in people who exhibit self-discipline and personal authenticity.

7) **Interpersonal (Social) intelligence:** The ability to work effectively with others, noticing their moods, motivations and feelings (social activity, cooperative learning, teamwork). These persons are able to relate to other people, and display empathy and understanding, to notice their motivations and goals.

8) **Naturalistic:** The ability to discriminate among living things and exhibit sensitivity to one's natural surroundings. We can see this type of ability in botanists, zoologists, ecologists, explorers, farmers, and hunters.

According to Howard Gardner all humans have all the eight types of intelligences. However, the strength in each intelligence area varies from person to person. The goal of the teacher is to develop a repertoire of learning activities and approaches that capitalize upon each of the eight intelligences in order to "help students use their combination of intelligences to be successful in school to help them learn whatever it is they want to learn as well as what the teacher and society believe they have to learn". The idea is not to teach every subject in eight different ways; the idea is not even to ensure that every student develops every intelligence. The best use teachers can make of their understanding of Gardner's theory of multiple intelligences is to help them identify and respond to student's needs.

Check Your Progress 2

Note: i) Write your answers in the space given below.
ii) Check your answers with the answers given at the end of this Unit.

Describe the eight intelligences of Howard Gardner's theory of multiple intelligences.

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9.6 COMPONENTS OF MULTIPLE INTELLIGENCES

Gardner originally identified eight core intelligences, which are given in section 9.5. The components of multiple intelligences are discussed below with examples.

1) **Visual-spatial intelligence**

The ability to understand spatial relationships and to perceive and create images (visual art, graphic design, charts and maps). Such persons can think and visualize a future result through pictures.

Possible occupation: Architects, sculptors, sailors, and photographers.

Famous personality: Picasso, Frank Lloyd Wright.

2) **Bodily-kinesthetic intelligence**

The ability to use the physical body skillfully and to take in knowledge through sensation (coordination, working with hands). Here, we use our body skillfully to solve problems, create products or present ideas and emotions.

Possible occupation: Athletes, dancers, actors, artistes etc.

Famous personality: Charlie Chaplin, Diego Maradona, Michael Jordan, Sachin Tendular, Dev Anand, Madhubala, Birju Maharaj.

3) **Musical intelligence**

The ability to make or compose music, to sing well, or understand and appreciate music.

Possible occupation: Musicians, composers, and recording engineers.

Famous personality: Mozart, AR Rehman, Gulzar, RD Burman, Kishore Kumar, Lata Mangeshkar.

4) **Linguistic intelligence**

The ability to communicate through language (listening, reading, writing and speaking).

Possible occupation: Authors, journalists, poets, orators and comedians.

Famous personality: Charles Dickens, Abraham Lincoln, T.S. Eliot, Sir Winston Churchill.

5) **Logical-mathematical intelligence**

The ability to understand logical reasoning and problem solving.

Possible occupation: Engineers, scientists, economists, accountants, detectives and members of the legal profession.

Famous personality: Albert Einstein, Shakuntla Devi, Vishwanathan Anand, John Dewey.

6) **Interpersonal (Social) intelligence**

The ability to work effectively with others, noticing their attitudes, motivations and feelings (social activity, cooperative learning, teamwork). These persons are able to relate to other people, and display empathy and understanding, to notice their motivations and goals.

Possible occupation: Teachers, facilitators, therapists, politicians, religious leaders, and sales people.

Famous personality: Mahatma Gandhi, Mother Teresa, Swami Vivekananda, S. Radha Krishnan.

7) **Intrapersonal intelligence**

The ability for self-analysis and reflection – to be able to understand one's own behaviour and feelings and to assess one's accomplishments, to review one's behaviour and innermost feelings, to make plans and set goals, the capacity to know oneself.

Possible occupation: Philosophers, counsellors

Famous personality: Eleanor Roosevelt, Plato.

8) **Naturalist intelligence**

The ability to understand features of the environment (interest in nature, environmental balance, ecosystems).

Possible occupation: Farmers, botanists, conservationists, biologists, environmentalists.

Famous personality: Salim Ali, Charles Darwin.

Check Your Progress 3

Note: i) Write your answer in the space given below.
ii) Check your answer with the answer given at the end of this Unit.

Write the names of five famous personalities on the basis of Multiple Intelligences Theory.

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9.7 IMPLICATIONS OF MULTIPLE INTELLIGENCES THEORY

The theory of multiple intelligences builds a strong basis for the concept of a comprehensive learning plan in institutions, which can improve student's academic achievement. In this competitive era, a holistic approach towards developing intelligences is much needed to enhance student's learning, therefore, while designing instruction we can use multiple intelligences. Some implications are as follows:

- The institutions can address the challenge of integrating emotional intelligence into the curriculum so that the students are emotionally strong too and not only academically intelligent. For this we need to consider about all the types of intelligences also while designing instruction. We need to be guided about the multiple intelligences.
- The ODL specialist/instructional designer can incorporate a variety of stimuli and use divergent delivery approaches, so that students get more opportunities to address their own specific learning needs.
- Addressing multiple intelligences assists in increasing attention and interest, and the assimilation of course material.
- Intervention programs that focus on understanding, regulation, facilitation, and expression of emotions are significant to student's learning, so while designing instruction, we have to keep in mind the above components.
- Designing instruction that involves students in personal and meaningful learning experiences will contribute to higher academic achievement, as it leads to development of an aspect of multiple intelligences.
- A teacher with knowledge of multiple intelligences can create a student-oriented learning environment. Such knowledge helps educators deal constructively with the instructional needs of a diverse student population. Therefore, instruction materials are to be designed for catering to the needs of diverse learning groups by utilizing multiple intelligence theories.

Check Your Progress 4

Note: i) Write your answer in the space given below.
ii) Check your answer with the answer given at the end of this Unit.

Describe the implications of multiple intelligences theory.

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9.8 LET US SUM UP

In this unit, we studied intelligence and the theory of multiple intelligences, which was developed by Howard Gardner. He defined intelligence as; "bio-psychological potential to process information that can be activated in a cultural setting to solve problems or create products that are of value in a culture" (Gardner, 1993).

Gardener further argued that with practice, intelligences can be developed into eight areas: (1) linguistic (words); (2) logical-mathematical (numbers); (3) spatial (pictures); (4) musical (musical/rhythmic); (5) bodily-kinesthetic (movement); (6) interpersonal (people); (7) intrapersonal (self); and (8) naturalistic (flora and fauna).

Persons with verbal/linguistic intelligence have the ability to think in words and to use language to express and appreciate complex meanings. Logical/mathematical intelligence enables a person to calculate, quantify, and perform complex mathematical operations. Persons with visual/spatial intelligence can perceive the visual world accurately and perform transformations and applications via mental imagery. Those individuals who possess abilities to pitch, melody, rhythm, and tone are known to have musical intelligence. Bodily-Kinesthetic intelligence indicates one's ability to use body in differentiated ways for both expressive (e.g., dance, acting, etc.) and goal-directed activities (athletics). Intrapersonal intelligence deals with self-appraisal, and self-management while the interpersonal intelligence pertains to the understanding of other people. Naturalistic intelligence gives one a sense of strong understanding for living and natural things (plants, animals, geology, etc.). The theory of multiple intelligences has great educational implications as by incorporating suitable activities into the curriculum, we can help students develop their intelligences.

9.9 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

Please read section 9.3 and write about dimensions of intelligence i.e. successful intelligence, practical intelligence, moral intelligence, social intelligence, and emotional intelligence.

Check Your Progress 2

Please see section 9.5.

Check Your Progress 3

Write the names of any five personalities that you have read about.

Check Your Progress 4

Please see section 9.7. Please write about integrating emotional intelligence in the curriculum, and how including it can increase better understanding.

UNIT 10 THE 4C/ID (FOUR COMPONENT/ INSTRUCTIONAL DESIGN) MODEL

Structure

10.1 INTRODUCTION

Most instructional design models are focused on loosely fragmented isolated components/activities in learning, such as context, methods, and media. They also include design, development, and delivery, together making it a linear process, which is difficult to understand until the completion of the process. This makes instructional design a complex process, beyond the 'design'. However, traditional instructional design models try to simplify educational transactions into simple learning tasks and assume that complex learning is possible by sequencing a string of simplified tasks. In reality, this does not happen, as knowledge in specialized area is growing at a much faster rate than ever before. For example, think of a discipline like medicine. In the early Shakespearean era, a dentist would require a drill, a saw, forceps, and pliers for removing teeth. Use of local anesthesia was unknown, and hence, the speed of action was the performance consideration. Compare this to the situation today, where advancements in medical sciences are vast, and the competent physicians and surgeons today need to master complex skills and competencies to perform better.

Your decision would be specific to your situation. But, what these two situations, explained above, tell us is that the development of expertise is dependent on the particular time, and is integrated with technology. We can't develop expertise through simple instructional design models. Considering this, van Merriënboer, Jelsma, and Pass (1992) proposed the four component instructional design (4C/ID) model for complex cognitive skills. Over the years ,Jeroen J.G. van Moerriënboer has emerged as the major contributor to this instructional design model. In this unit, we shall discuss a brief overview of the components of the model, and how you can use this for complex learning. This model provides us a mechanism to design learning in complex domains for the integration of higher-order skills and appropriate transfer of learning.

10.2 LEARNING OUTCOMES

After going through this unit, you should be able to:

- define complex learning;
- list the four components of the 4C/ID model;
- describe the philosophical and theoretical bases of the 4C/ID model;
- identify the notation of the various components in the 4C/ID blueprint;
- describe the ten steps of the 4C/ID model; and
- discuss the educational implications of the 4C/ID model.

10.3 PHILOSOPHICAL AND THEORETICAL FOUNDATIONS OF 4C/ID MODEL

The 4C/ID model is based on three concepts: complex learning, holistic design, and transfer of learning. It believes that in certain subjects , the development of professional competencies is so complex that traditional instructional design can not produce the transfer of learning, as they do not follow a holistic design approach. Let us discuss these three concepts first.

Complex Learning

Complex learning involves the integration of knowledge, skills, and attitudes that deal with the whole rather than parts. It focuses on authentic learning tasks based on real-life tasks, to help the learners develop reasoning and problem-solving skills. A complex learning topic comprises of sub-topics or 'constituent skills' that can have two types of hierarchy – horizontal and vertical. While the horizontal hierarchy represents the coordinate relationship that can be temporal or simultaneous, the skills in vertical relationships are in top-down or sub-ordinate and super-ordinate relationships, meaning that one must learn the sub-ordinate skills first to learn the next higher skills. In the horizontal type, one may learn in a different order, but learning is not complete unless all the constituent skills are completed. Some of the constituent skills may require rules and development of schema to have expertise. When expertise is developed, conscious control is no longer required, as the skills are applied unconsciously/automatically (e.g., driving a car). While developing training for complex learning, it is important to identify *the recurring* and *non- recurring* constituent skills. The recurring constituent skills may be highly similar in all problems, but the non-recurring skills differ from problem to problem and may depend on the reasoning and mental models of the domain. For example, 'review of the literature' in different domains/topics would require different non-recurring constituent skills of understanding the particular domain/topic, while the recurring skills are the use of thesauri and subject descriptors that would be the same in different topical searches. Thus, complex learning requires coordination and integration of a variety of cognitive skills for development of professional competencies.

Holistic Design

To develop professional competencies in complex learning areas, the design approach should be *holistic* rather than *atomistic*. The 4C/ID model proposes a holistic design, to deal with complexity, by considering all the interconnectedness of the elements.

The holistic design approach denounces the 'compartmentalization' of *declarative* and *procedural* learning. Traditional instructional design models believe in chunking (fragmentation) of performance objectives. However, in the 4C/ID model, each objective corresponds with one constituent skill, and new skills are gradually added to complete the instruction. There may be numerous interactions in learning of different constituent skills in a coordinated manner to simulate real life task performance.

Transfer of Learning

The next important concept, on which 4C/ID is based, is, transfer of learning. It believes in the use of authentic learning tasks to develop an integrated knowledge base. In the transfer process, constituent skills are developed, where the application of rules is automated to solve familiar problems. This leads to reflection on the quality of the solution offered to a new situation, and if, accepted the same also becomes the rule for automation. The design of complex learning should focus on the transfer of learning opportunities to develop expertise in a cyclical manner. The design may include numerous practice items in sequence to develop the constituent skills in an integrated manner.

The 4C/ID model has its theoretical bases on the following:

- Cognitive Load Theory
- Schema Induction Theory
- Elaboration Theory
- Adaptive Control of Thought
- Power Law of Practice.

Cognitive Load Theory

According to the Cognitive Load Theory (CLT), which we discussed in Unit 8, the human brain has a limited working memory capacity to process information and transfer it to long-term memory. Therefore, the instruction we provide to learners should not add to the load on the cognitive capability of the learner. Cognitive load can be of three types – intrinsic, extraneous, and germane. *Intrinsic load* is a direct function of the learning task that may have more elements to process, than the power of working memory. *Extraneous load* is the load due to non-relevant aspects of the instructions, and *germane load* is related to the processes that directly contribute to learning for schema construction and rule automation. An instructional design that is low in extraneous load uses intrinsic load by appropriate instructional procedure and encourages the learner to consciously use greater germane load, as it has greater potential for optimizing learning.

Schema Induction Theory

We have discussed Schema earlier in Unit 8 of Block 2. The schema induction theory proceeds general to specific. For example, when a learner continues to read a topic such as Behaviourism, the more specific schema strengthen, this for highly familiar words such as behaviour, observation and objectives.

Induction is the process of including generalization and discrimination, by which learners mindfully abstract away from their concrete experiences. It is a form of schema construction that is especially important for learning from learning tasks in real or simulated task environments. Well designed learning tasks offer the possibility of concrete experiences, that help to develop new schema or help in modifying existing ones in the long-term memory.

Elaboration Theory

We have discussed the Elaboration Theory in Unit 7. Meaningful learning is possible, when the learning material has new information, and also when it helps the learners to elaborate on the existing information by developing schema, analogies, concept maps, etc., of their own. Elaboration is a strategic and controlled cognitive process that requires learners to explore how new information relates to other contexts. While collaboration between learners helps in the elaboration process, well designed supportive information provides a bridge between what the learners already know, and what they should know, to perform well.

Adaptive Control of Thought

It proposes that automation of rules and their compilation results in knowledge formation to speed up performance. In the early stages of complex learning, learners receive information through textbooks, lectures, etc. These are encoded into memory and are referred to as weak methods. According to the adaptive control of thought, it is a slow process. These are innate and can be applied to any domain. However, if procedural information can be encoded in a logical sequence in IF… THEN… ELSE mode, rules can be compiled, like that of a computer program to speed up performance and increase efficiency.

Power Law of Practice

We know that 'practice makes one perfect'. Repeated practice of various components of a task helps in developing high levels of automaticity, and thereby, the development of expertise and appropriate transfer. According to the Power Law of Practice, "the log of the time to complete a response will be a linear function of the log of the number of successful executions of that particular response". In simple words, the higher the practice, the better the performance and efficiency.

In the next section, we will see that the 4C/ID model uses these theories and conceptual foundations effectively to develop appropriate training designs for complex learning to develop professional competencies in an integrated manner.

Check Your Progress 1

Note: i) Write your answers in the space given below.
ii) Check your answers with the answers given at the end of this Unit.

1) What is complex learning?

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2) Describe the theoretical basis of the 4C/ID model.

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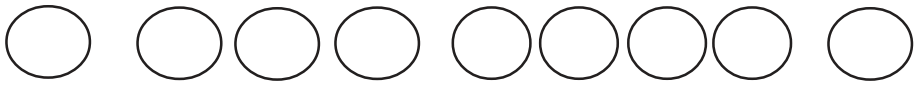
10.4 THE FOUR COMPONENTS: BLUEPRINT

The four components of the 4C/ID model has been described by Merrienboer and Kirschner (2007). This model has four components: Learning Tasks, Supportive Information, Procedural Information, Part-Task Practice. Let's discuss the four components in detail.

Learning Tasks

Learning tasks are concrete, authentic, whole-task experiences that are based on real-life tasks aimed at developing knowledge, skills and attitudes in an integrated manner. You are expected to work on the whole task and a sequence of learning tasks completes the activity. In the blueprint for 4C/ID, the learning task is represented by a circle. A set of learning tasks would look like this:



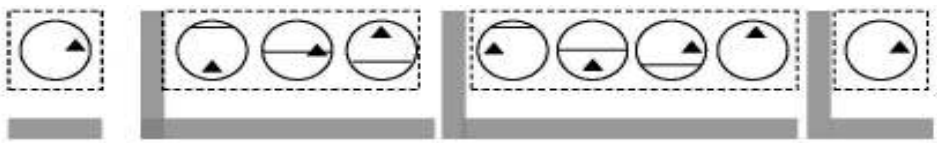
Learning tasks vary according to the context or situation, and also according to the characteristics of the task itself, the way the task is presented. A sequence of different learning tasks is the backbone of complex learning, as it allows the learner to extract more general information from the details of each learning task. Schematically, the variability is represented within the circle as follows:

The learning tasks are related to 'constituent skills' that make up real-life experiences. According to the 4C/ID, the constituent skills are *aspects* rather than *parts* of complex learning. A learning task needs to be simple in the beginning, and thus these should be sequenced with a particular difficulty in mind. A group of learning tasks with similar levels of difficulty is called a *'task class'*. A group of task class also requires the same body of knowledge to perform. In the blueprint for 4C/ID, they are represented as follows:

As the learners start working on new learning tasks, they would require *support* and *guidance*. *Here, support* is related to helping the learner to perform the task well by providing assistance on the product involved in training. Guidance is related to helping the learner to understand the processes and successfully solve the learning task. The guidance and support can be attributed as a process of 'scaffolding', where the need for support reduces as the learner gains experience. Diagrammatically, it is represented in the blueprint as grey/half-tone in the circles. More grey the tone, the higher is the need for support.

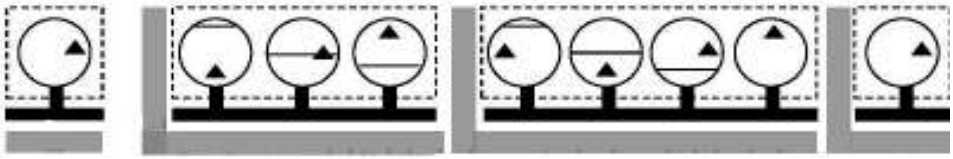
Supportive Information

Supportive information is helpful for learning and solving problems and using reasoning aspects of learning tasks. Supportive information is specified per *'task class'*. In order to explain supportive information, the 4C/ID model says, "it is the bridge between what learners already know and their work on the learning task". It may be treated as the theoretical basis of the constituent skills in the task class. Instructional methods for presentation of supportive information promote schema construction through elaboration to help students develop relationships between newly presented knowledge and previous knowledge. In the 4C/ID blueprint, supportive information is represented by an L-shape shaded area below the task class.



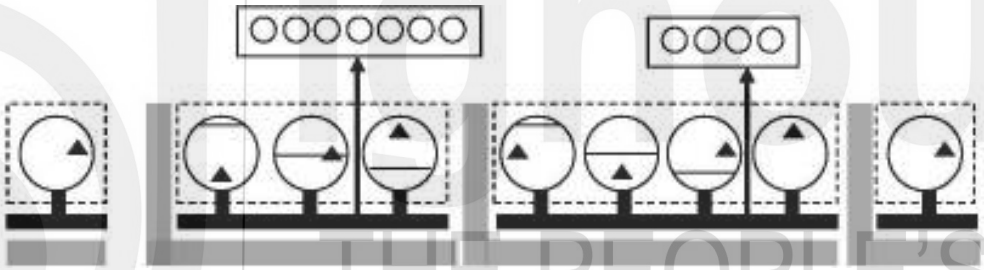
Procedural Information

This is a must for learning and performing the routine aspects of learning tasks. Through this component, the instructional designer specifies how to perform the routine aspects of the task. It is best presented *just-in-time*, precisely when the learners need it. Procedural information is primarily *recurrent* in nature, and over time, learners do not require it as they develop expertise due to a high level of automaticity. In the blueprint for 4C/ID, procedural information is represented as a black beam.



Part-Task Practice

These are practice items provided to help the learners to develop a high level of automaticity in routine aspects of a task. These are distinct practice items based on procedural information to provide additional practice for developing expertise. Normally, the learning tasks would provide concrete experiences to practice constituent skills. However, to have a high level of automaticity, more practice items may be required. In the blueprint for 4C/ID, part-task practice is indicated by a series of small circles.



A blueprint for the 4C/ID model can be presented diagrammatically as follows (See Fig. 10.1).

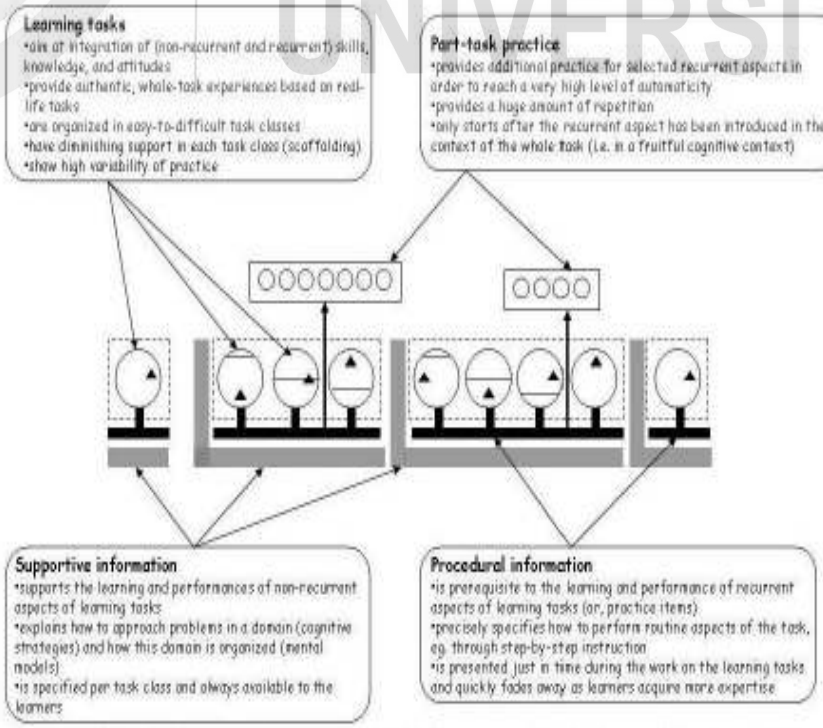


Fig. 10.1: A Schematic blueprint for 4C/ID Model

Adapted from Source van Merrienboer, J.J.G., & Kirschner, P.A. (2007). *Ten steps to complete learning.* Mahwah, NJ: Lawrence Erlbaum.

Check Your Progress 2

Note: i) Write your answer in the space given below.
ii) Check your answer with the answer given at the end of this Unit.

Describe the four components of the 4C/ID model.

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10.5 TEN STEPS FOR 4C/ID

The blueprint for 4C/ID model is relatively complex, though we have tried to explain above in a simple manner. By now, you must have started asking yourself, how do I apply the model in a real instructional design situation? Van Merriënboer and Kirschner (2007) have given ten steps as a practical and simplified version of the 4C/ID model. They also emphasize that the ten steps are "specifically directed towards programs of vocational and professional education, job-oriented university programs (e.g., medicine, business, administration, law), and competency-based training program in business, industry, government, and military organizations" (p.10). The ten steps can be applied to both short-term and long-term training ranging from several weeks to several years. In the context of the curriculum, the ten steps of the 4C/ID model can be applied to design instruction for one or more competencies. It may also be noted that 4C/ID model is not a conventional instructional design model that follows the common ADDIE approach to cover implementation and evaluation. In fact, the 4C/ID model is only a design blueprint that is based on an analysis of the content, context, and constituent skills. The steps are given in Table 10.1. We will discuss these ten steps briefly in this section.

Table 10.1: Ten Steps of 4C/ID Model

Components of 4C/ID	Steps
Learning Tasks	1) Design Learning Tasks 2) Sequence Task Classes 3) Set Performance Objectives
Supportive Information	4) Design Supportive Information 5) Analyze Cognitive Strategies 6) Analyze Mental Models
Procedural Information	7) Design Procedural Information 8) Analyze Cognitive Rules 9) Analyze Pre-requisite knowledge
Part-task Practice	10) Design Part-task Practice

- **Learning Tasks**

Step 1: Design Learning Tasks

In most instructional design models, the subject matter and objectives are first decided. But in the 4C/ID model, you first identify the learning tasks that are whole-task activities. In real life, problems are ill-defined or poorly structured, and therefore, the solution to each problem also differs. The identification of learning tasks, that truly represent the expected learning is the starting point. For this, professionals in the domain area

can be interviewed to help identify and develop scenarios. These scenarios can form the basis of constituent skills development.

Learning tasks also have support and guidance. To design support, you must provide sufficient background information on the learning task and the theoretical basis and guidance to develop problem-solving skills. Each type of learning task would require different levels of support, and instructional strategies may include a case study, the use of reverse troubleshooting, imitation, etc. For problem-solving guidance, you need to consider the use of illustrative examples, worksheets, etc.

Step 2: Sequence Task Classes

Though the 4C/ID model uses authentic whole-task learning, it does not recommend immersing the learners into difficult tasks in the beginning. It emphasizes sequencing the learning tasks into *task classes*. The task classes are grouped based on the known to unknown, to provide learning within the *zone of proximal development* of the learner. To group the learning task, you should identify the 'simplifying conditions' to sequence learning. When learning tasks are not grouped according for simplifying conditions, emphasis manipulation is used for progressively increasing complexity.

Step 3: Set Performance Objectives

The performance objectives are the 'exit behaviour' of the learners, and, therefore, should be set in measurable terms covering the *action verbs*, *conditions*, and *standards* of measure. This is a normal activity in all the instructional design models. In the 4C/ID model, the focus is on the constituent skills. The constituent skills are spliced into all the component elements and are mapped in to a hierarchical pattern to show coordinate and sub-ordinate relationships. The performance objectives are then, classified into three major groups:

a) The skills that will or will not be taught. By default, constituent skills are taught.
b) Skills that will be treated as non-recurrent, recurrent or both. By default, constituent skills are treated as non-recurrent, involving schema-based problem solving.
c) Skills that need to be automated or not. By default, recurrent constituent skills are classified as skills that need not be automated. However, if recurrent skills are classified as to be automated, additional part-task practice is also required.

- **Supportive Information**

Step 4: Design Supportive Information

Supportive information refers to: (a) general information on solving problems within the task domain; (b) examples that illustrate domain-specific information; and, (c) cognitive feedback on the quality of task performance. The general information should follow the Systematic Approaches to Problem-Solving (SAP) and present domain knowledge through different models: conceptual, structural and causal. *Conceptual models* revolve around descriptions of objects, events and activities; whereas, *structured models* describe how objects, events and activities are organized to reach a specific goal. *Causal models* deal with cause and effect, interpretation and prediction of events. The presentation strategy of the support information could follow a *deductive* or *inductive strategy*. Deductive presentation strategy follows an abstract to concrete illustration, whereas, inductive strategy follows concrete to abstract information to illustrate the relevant subject information. The presentation of supportive information may also follow a guided discovery strategy, leaving the student to independently determine and articulate general information and construct meaningful relationships. For the improvement of the learner, the quality of the feedback is very important as a support mechanism for the learning task and how

the learners do task-performance. This is called 'cognitive feedback', which allows the learner to reflect on the quality of the solution or the problem solving process. These reflections are called as 'double loop learning'(Argyris & Schon, 1978).

Step 5: Analyze Cognitive Strategies

This is an additional step to further detail the Systematic Approach to Problem-Solving (SAP), if detailed supportive information is not available. This step helps to analyze the cognitive strategies employed by proficient task performance to solve problems in the domain. It focuses on identification of non-recurrent aspects of carrying out the task. It helps us to develop the content for the task class with flowcharts and sequences the task classes to help achieve constituent skills. The result of cognitive strategy analysis is a set of sub-goals that the learner would perform to complete the learning task.

Step 6: Analyze Mental Models

"What we know determines what we see and not the other way round."

This is also part of Step 4, and should be worked out, if not already available as supportive information. We have seen that information presentation can be done as conceptual, structural and causal models. If such mental models are not available as learning support information of a task, we must analyze it to articulate a mental model appropriate to the domain knowledge. The mental models are dependent on our previous knowledge and experience. They may be presented as concept maps, organograms, pictures, diagrams, etc., to convey meaning.

- **Procedural Information**

Step 7: Design Procedural Information

The description of steps in the 4C/ID model is similar to what is meant by procedural information. It is the process to codify the procedural information related to the recurrent aspects of the learning tasks. The procedural information could be of three types: just-in-time (JIT), demonstrations, and corrective feedback. On web-pages and multimedia learning systems, we can use pop-ups as JIT to help the learners. The JIT information is often called 'how-to-do instructions' as given in the operation manuals of electronic gadgets for home use. You, as a designer must identify the location and timing of the procedural information to be provided as JIT. JIT information can also take the form of demonstrations to show, illustrate and explain a procedure. For example, the steps in check-in of air passengers can be demonstrated visually through a video or animation. The information presentation for procedural information can be through unsolicited presentation (as a must read for the learners), on demand presentation (if they need it, they ask for it, e.g., help systems or search facilities), and advanced memorization (where the procedural information becomes a prerequisite to undertake a learning task, and should be there in the long-term memory of the learner). Corrective feedback is given on recurring aspects of the learning task. In contrast to cognitive feedback, the role of corrective feedback is to detect and correct errors. Well designed feedback is about informing the learners about the nature and reason for the error, and not just to inform them that the task was done correctly or incorrectly. One can take a minimalist instruction approach while designing procedural information for corrective feedback and include the following:

- a description of the condition resulting into the error;
- information on likely cause(s) of the error, and how it could have been avoided; and
- statement for correcting the error.

Step 8: Analyze Cognitive Roles

This is part of the procedural information in a 4C/ID model, and should be conducted if rules are not available to perform a learning task. This is also applicable to part-task practice. It is important to identify and define the rules and procedures to perform a recurrent aspects of the constituent skills to correctly perform a task. The rule-based analysis of the procedures, of the learning task, helps in designing mastery learning by providing an opportunity to practice and receive feedback.

Step 9: Analyze Prerequisite Knowledge

This step is important if you have undertaken the cognitive rule analysis to develop the rules. To apply the if-then rule and/or carry out procedural steps correctly, the learners require some pre-requisite knowledge. This pre-requisite knowledge is part of the existing cognitive rule that the learner has assimilated in his/her long-term memory.

- **Part-task Practice**

Step 10: Design Part-task Practice

Part-task practice is one of the four components of the 4C/ID model. While the other three are always necessary, part-task practice is not. This is required, only if there is a need, for additional practice of recurrent aspects of the constituent skills. This step is necessary when a high level of automaticity is expected from the learner. Suppose you want to develop a course on plant taxonomy. The learners are expected to identify unknown plants to determine the scientific name of the plant. To achieve this goal, you have to give a large number of part-task practice items, of a variety of plants, with different characteristics from different *genus* and *species*. At a lower level, examples of part-task practice are drilling addition, subtraction and multiplication tables. Part-task practice is very simple and straightforward, as it contains a set of if-then rules for performance of a recurrent constituent skill. Practice items can be of three types: *results-oriented* or *produce type*, *edit type;* and *recognize type*. The produce type practice items result in some kind of output, while the edit type expects the learner to do correction/editing. The recognize type of practice items require learners to select a correct procedure or object from a list of options. The objective of practice items is to provide high level of accuracy in performance to develop mastery learning. Through 'overtraining' or excessive training, first accuracy is obtained, then accuracy and speed are focused, and finally, the part-task practice is carried out simultaneously with other tasks in time-sharing conditions within the whole-task activity.

Check Your Progress 3

Note: i) Write your answer in the space given below.
ii) Check your answer with the answer given at the end of this Unit.

Describe the ten steps of the 4C/ID model.

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10.6 APPLICATION OF 4C/ID: EXAMPLE OF WIKI SKILLS TRAINING

In this section, to illustrate the use of the 4C/ID model, we take the example of Wiki skills training conducted by the WikiEducator.org and have converted the training design up to the Wikibuddy level (this is a term for the intermediate level of skill in WikiEducator). While the illustration has not been tested, in practice, the blueprint would look something like Table 10.2 to Table 10.4. Figure 10.1 is just a schematic representation, which, you as an instructional designer, may or may not develop. But, what is important in the development of the blueprint is given in the wiki example here. This is just a rudimentary and highly simplistic representation of the 4C/ID model, though, in practice for complex learning, it is done in a further detailed manner. The present example will take three days in a face-to-face workshop, whereas the same will take about a month in an online environment. It may also be noted that the proponents of the 4C/ID model recommended not to use this model for short training programmes that may be done in a few hours. *You are advised to use this section just for illustration only.*

Table 10.2: 4C/ID Blueprint for Wiki Skills Training-1

<table>
<tr><td colspan="3">Performance Objectives: Participants shall be able to
• Use wiki skills at the level of WikiBuddy; and
• Use wiki to prepare webpages on Wikieducator.</td></tr>
<tr><td colspan="3">Task Class 1: Basic formatting using wiki</td></tr>
<tr><td>Learning Task 1:
Completion: The learners are asked to go to the user page, and write a paragraph about themselves, and undertake to make some aspects bold to highlight.</td><td rowspan="5">Procedural Information:
A video shows online how different tasks are performed, including step-by-step approach. In a face-to-face workshop, this is demonstrated to the learners just-in-time. The prerequisite is to have an account on WikiEducator.</td><td rowspan="5">Part-task Practice:
Though no part-task practice is suggested specifically, the learners may practice move to master the wiki tags to undertake basic rext formatting.</td></tr>
<tr><td>Learning Task 2:
Completion: Continuing from Task 1, learners make some part of the text typed into italics.</td></tr>
<tr><td>Learning Task 3:
Completion: Continuing on learning Task 2, learners add more content in the user page to create headings and sub-heading.</td></tr>
<tr><td>Learning Task 4:
Completion: Bullet lists are prepared.</td></tr>
<tr><td>Learning Task 5:
Completion Numbered lists are prepared in the user page.</td></tr>
<tr><td colspan="3">Supportive Information: Tutorial 1-4 on Wikieducator provides the support information that the learner is supposed to read before working on the task.</td></tr>
</table>

Table 10.3: 4C/ID Blueprint for Wiki Skills Training-2

<table>
<tr><td colspan="3">Performance Objectives: Participants shall be able to
• Use wiki skills at the level of WikiBuddy; and
• Use wiki to prepare webpages on Wikieducator.</td></tr>
<tr><td colspan="3">Task Class 2: Basic wiki editing skills</td></tr>
<tr><td>Learning Task 1: Imitation and Completion: External link using piped link feature to be seen from a Wikieducator page, and then a similar activity be worked out in the user page.</td><td rowspan="3">Procedural Information: A video shows online how different tasks are performed, including a step-by-step approach. In a face-to-face workshop, this is demonstrated to the learners just-in-time. The prerequisite is to have completed Task Class 1 and 2.</td><td rowspan="3">Part-task Practice: Though no part-task practice is suggested specifically, the learners may practice more to master the use of wiki for community-based learning.</td></tr>
<tr><td>Learning Task 2: Imitation and Completion: Explore the use of internal links, and create an internal link to create 'my sandbox' in the user page.</td></tr>
<tr><td>Learning Task 3: Imitation and Completion: Learner will upload his/her own picture, after looking at the tags used for insertion and uploading an image.</td></tr>
<tr><td colspan="3">Supportive Information: Tutorial 5-6 on Wikieducator provides the support information that the learner is supposed to read before working on the task.</td></tr>
</table>

Table 10.4: 4C/ID Blueprint for Wiki Skills Training-3

<table>
<tr><td colspan="3">Performance Objectives: Participants shall be able to
• Use wiki skills at the level of WikiBuddy; and
• Use wiki to prepare webpages on Wikieducator.</td></tr>
<tr><td colspan="3">Task Class 3: Activec wiki user skills</td></tr>
<tr><td>Learning Task 1: Exploration and Completion: Learners explore recent changes and history of a specific page to understand different aspects.</td><td rowspan="4">Procedural Information: A video shows online how different tasks are performed, including a step-by-step approach. In a face-to-face workshop, this is demonstrated to the learners just-in-time. The prerequisite is to have completed Task Class 1 and 2.</td><td rowspan="4">Part-task Practice: Though no part-task practice is suggested specifically, the learners may practice more to master the use of wiki for community-based learning.</td></tr>
<tr><td>Learning Task 2: Completion: Learners undertake edit reverse by making a deliberate mistake.</td></tr>
<tr><td>Learning Task 3: Completion: Learners communicate with other wikieducator members by sending messages through the user talk page and also use discussion for subject specific conversation on a page.</td></tr>
<tr><td>Learning Task 4: Initiation: Inserting pedagogical template on a page by imitating the source code in a page that uses the same.</td></tr>
<tr><td colspan="3">Supportive Information: Tutorial 7-9 on Wikieducator provides the support information that the learner is supposed to read before working on the task. Also, read the tutorial on pedagogical templates.</td></tr>
</table>

10.7 EDUCATIONAL IMPLICATIONS OF 4C/ID MODEL

As discussed earlier, the 4C/ID model is more suited for professional and vocational areas, where skill development is highly important. The model is also relevant for the development of training programmes for complex skills, where transfer of skills is the most important learning outcome. Van Merriënboer et al. (2002) say that the model is "not developed for teaching conceptual knowledge or procedural skills per se. It also is not very useful for designing very short programs that only take an instructional time of hours or a few days" (p. 55). When the 4C/ID model is used, the blueprint itself is not sufficient for delivery of instructions, and therefore, more detailed analysis and material development are required.

The 4C/ID model is a very useful model for individualized and adaptive learning in a computer-based learning environment, especially when using multimedia. Since the model uses pre-knowledge assessment, and work based on practice items, computer-based systems are useful for both cognitive and corrective feedback. Multimedia can also enable a dynamic sequence of the learning task, and it can provide JIT support information more accurately. Support information can also be provided through multiple media, including video demonstrations of difficult scenarios. The use of media can facilitate the development of mental models using a variety of visual tools.

The 4C/ID model encourages a mix of constructivist and instructivist approaches, and, therefore, is an eclectic model that believes in whole-task authentic activities to practice learning. It provides an opportunity for the learner to develop his/her own schema by reflection, and at the same time, the rule-based procedural information provides skills to be developed in a systematic way by the provision of feedback. The presentation of the learning tasks follows the cognitive load theory and therefore, helps the learner to develop constituent skills for professional competencies.

The 4C/ID model is more suitable for self-directed learning, where individuals are responsible for their learning, and are ready to undergo rigorous training. Because of this, it is also suitable for e-learning applications. The support and guidance for learning tasks in the 4C/ID model ensure a high degree of self-learning, as also the supportive information and procedural information. The use of variability of practice in the learning task also enables individualized learning, which motivates the learners to learn on their own.

While the 4C/ID model does not include media selection within its framework, it encourages the use of a variety of media. However, the primary medium always involves a real or simulated task. Consequently, audio, video, animation, graphics, case study (in print/in video), etc., can be used in all the four components discussed earlier. The model is more suitable for a hypertext environment, and therefore, the use of media is not a constraint, but a rational decision has to be taken using other media selection methods available.

The 4C/ID model has proved its effectiveness, in terms of transfer of training in comparison to other conventional training strategies, in Computer Science (van Merriënboer, 1990), statistical analysis (Paas, 1992), and other areas of competence based domain knowledge.

Check Your Progress 4

Note: i) Write your answer in the space given below.
ii) Check your answer with the answer given at the end of this Unit.

Discuss the educational implications of the 4C/ID model for designing instruction.

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10.8 LET US SUM UP

In this unit, we discussed the four components of the instructional design model proposed by van Merriënboer and others to develop professional competencies in a complex domain. The four components are learning task, supportive information, procedural information, and part-task practice. We discussed the conceptual and theoretical foundations of the 4C/ID model and identified that the model is based on the concept of complex learning, holistic design and transfer of learning, The theoretical bases of the 4C/ID revolves around cognitive load, schema induction, elaboration, adaptive control of thought, and power law of practice. We also discussed the ten steps of 4C/ID to help you apply the model for designing instructions.

The learning task is an authentic whole-task activity, which is identified first, and then the support and guidance information, including its variability in practice is decided. The learning tasks are grouped into task classes, and supportive and procedural information is developed to help the learner to complete the learning task and develop expertise by undertaking a series of tasks. This provides non-recurring experiences to understand and reflect on the solutions. Such a practice helps to generalize information for use in new contexts. When higher automaticity and expertise is required, more practice items are given for part-task practice, which are rule-based to provide corrective feedback. The 4C/ID model has proved highly effective in many disciplines, including computer science, statistics, business and law. It is also useful for self-directed learning and individual adaptive learning systems. It is an eclectic model that promotes both instructivist and constructivist learning and also encourages the use of multiple media, and is more amenable to the use of multimedia.

10.9 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1) Please read section 10.3. Explain how complex learning involves the integration of knowledge, skills and attitudes that deal with the whole rather than parts. Also write about the horizontal and vertical hierarchy that is present in a omplex learning topic.

2) Please read section 10.3. Write about the theoretical bases i.e. Cognitive Load Theory, Schema Induction Theory, Elaboration Theory, Adaptive Control of Thought, Power Law of Practice.

Check Your Progress 2

Please read section 10.4. Write about the four components of the 4C/ID model i.e. Learning Tasks, Supportive Information, Procedural Information, Part-Task Practice.

Check Your Progress 3

Please read section 10.5. Describe the ten steps of 4C/ID.

Check Your Progress 4

Please read section 10.7.

KEYWORDS

Authentic task: A task as it appears in real life.

Cognitive feedback: A type of feedback that allows the learner to reflect on the quality of found solutions or the quality of the problem solving process.

Cognitive skills: Cognitive skills are any mental skills that are used in the process of acquiring knowledge; these skills include reasoning, perception, and intuition.

Complex learning: The integration of knowledge, skills, and attitudes in a manner that deals with whole rather than only one part.

Constituent skills: Sub skills or component skills of a complex cognitive skill that may best be seen as aspects of the whole skill.

Corrective feedback: A type of feedback that gives learners immediate information on the quality of performance of recurrent aspects of a complex skill.

Double loop learning: Double loop learning happens when weaknesses in performance are detected and corrected in ways that involve the modification of the learner's underlying knowledge structures, norms, and objectives.

Emphasis manipulation: It is an approach to the sequencing of learning tasks in which different sets of constituent skills are emphasized in different task classes.

Schema: The word schema comes from the Greek word skhçma, which means shape, or more generally, plan.

Simplifying conditions: It is an approach to sequencing of learning tasks where conditions that simplify the performance of the complex task are used to define task classes.

Transfer of learning: The ability to transfer an acquired complex skill in new, unfamiliar situations.

Zone of proximal development: It is the difference between what a learner can do without help and what he or she can do with help.

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