SEQUENCING OF CONTENTS AND LEARNING OBJECTS – part II

SECUENCIACION DE CONTENIDOS Y OBJETOS DE APRENDIZAJE (II))

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Abstract: This is the second part of the article under the same name published in the previous issue of RED. It was then that we stated a vision of the selection and sequencing of learning objects in the context of curricular planning, from the constructivist perspective. In the field of web-based training, we pointed out the importance of having tools and autonomous criteria that guide this process on our own and external basis, above the prescriptions of technological tools, and from the need of having standardized formats to exchange data.

The above mentioned becomes more relevant in the field of e-learning for general purposes, in the areas of academic formation, corporate and general training. It covers the area of formal, non-formal and informal education as well. We have also mentioned the needs the e-learning industry has to fulfill at present in relation to instructional design of learning objects. These needs are both a priority and a challenge.

In the first part of this article we developed the constructivist perspective and the concept of technological tools as educational resources, as well as a revision of concepts that are related to e-learning, learning objects, reusable learning objects (RLO) and reusability. In this part, we'll deal with the basis for the theories that rule the procedures for selecting contents, the basic presupposition and the description of the sequencing techniques. In particular, we'll focus on three of them: Content Analysis Technique, Task Analysis Technique, and Elaboration Theory.

In our third and last part, we'll undertake several issues – not trying to solve them but just in their proposal as enunciation: Is the concept of *reusable* learning object compatible with the requirements of interdependence of the learning contents? If this is so, what are the requirements for those learning contents?

Keywords: Learning objects, reusability, usability, learning technology standards, e-learning, curricular design, content sequencing, Content Analysis Technique, Task Analysis Technique, Elaboration Theory.

Resumen: Esta es la segunda parte del artículo del mismo nombre publicado en el número anterior de RED. En él planteamos una visión de la selección y de la secuenciación de contenidos de enseñanza, en el contexto de la planificación curricular, desde la perspectiva de las corrientes del pensamiento constructivista. Señalamos la importancia de contar, en el campo de la formación apoyada en redes, con herramientas y criterios autónomos que guíen este proceso desde unas bases propias, externas y con preeminencia sobre las que derivan de la configuración de las herramientas tecnológicas, y desde la necesidad de contar con estándares de formato de intercambio de datos.

Si en general este planteamiento es importante adquiere especial relevancia en el contexto del *e-learning* de propósito general, tanto en el de formación como en el *e-learning* empresarial o en el universitario. Y por supuesto en el contexto de la formación reglada y de formación informal, o de la no reglada. También señalamos las necesidades que plantea la industria del *e-learning* en la actualidad en relación con el diseño instruccional de objetos de aprendizaje, necesidades que constituyen una prioridad y un desafío.

En la primera parte desarrollamos la perspectiva constructivista y la conceptualización de servicios y herramientas tecnológicas como recursos educativos, así como una revisión de los conceptos vinculados con el *e-learning*, objetos de aprendizaje, OAR y reusabilidad. En esta parte abordaremos la fundamentación de las teorías que rigen los procedimientos de selección de contenidos, los presupuestos básicos y la descripción de las técnicas de secuenciación. En particular nos centraremos en tres de ellas: La *técnica de análisis de contenidos*, la *técnica de análisis de la tarea* y la *Teoría de la Elaboración*.

Por último como conclusión, en la tercera parte, intentaremos abordar, no en su resolución sino solo en su propuesta como enunciado, varias cuestiones: ¿el concepto de objeto de aprendizaje *reusable* es compatible con los requisitos de interdependencia de contenidos de aprendizaje? Y si es así ¿qué requisitos han de cumplir éstos?

Palabras clave: Objetos de aprendizaje, reusabilidad, usabilidad, estándares de e-learning, e-learning, diseño curricular, diseño educativo, secuenciación de contenidos, Técnica de Análisis de Contenidos, Técnica de Análisis de la Tarea, Teoría de la Elaboración.

1. CONTENTS AND SEQUENCING.

Organization and sequencing of learning contents are both the core of the itinerary that will lead us to the design of learning processes.

We have already referred (Esteban, M y Zapata, M, 1992) to the realization and contextualization of the formative intentions, with a triple purpose – that the orientations of the actions and the formative interventions we perform
  - answer the specific needs of the students in a certain context
  - are coherent with the options that characterize the organizing institution, center or formative program,
  - include the curriculum precepts established by the administration for the formative program.

We have also seen (Esteban, M. and Zapata, M., 1992) that this fact has its effect in content selection and organization, that is, that the concretion of the educative objectives will lead the teaching-learning processes and that it will also have effects in the other aspects of the curricular planning, mostly in the selection and in the approach of the learning contents, and in the evaluation of the learning process. This seems obvious, it's implicit in any process of curricular planning, and has its correlation in the corresponding formative interventions.

Precisely, it should be pointed out that the various components of the Curriculum —rationale, aims, contents, evaluation and resources— which are usually treated separately are, in fact, interrelated. Therefore, in practice, we will have to check recurrently what we are doing, the results, compare them with the preset objectives and make the necessary improvements both in planning and in the formative intervention proper. This is so much so that we will have to look back to enrich and redefine our previous formulations as we proceed in the study of each component. This practice also affects the selection and sequencing of contents. As we will see, these processes are included in the techniques we will be describing most times.

Finally, we would like to mention that the considerations included in this work are closely connected with, or are the same, to the ones used for selecting, organizing and distributing learning contents in larger cycles than the ones of a formative module or of a curricular unit of any traditional program. The fact is that, for obvious reasons, this task is carried out by other instance and at other decision levels.

2. UNDERLYING ASSUMPTIONS IN THE SEQUENCING OF CONTENTS.

There are some **underlying assumptions** present when organizing and sequencing learning contents. These assumptions determine many of our options, such as:

+ **First. The general objectives set for each level in a plan,** previously agreed upon, will have to affect the formative action for each inferior level of a plan through the **general objectives established for that level and for the contents of that level.**

In this way, for instance, the previously set general objectives established for a formation program (masters, specialization,…) will have to affect the educational action through the general objectives in the different courses and in the contents established for each course. Likewise, these objectives —the general objectives of a course— will affect the general objectives of the different subject or curricular and learning content (conceptual, procedural and attitudinal) areas.

The progression of content by areas, courses, programs or formative levels is not done, as it is often assumed, in a linear fashion, as if it depended on a single variable: to divide a number of contents into different time units, or to divide contents according to their nature, but it responds to a multiplicity of criteria. Therefore, the progression may, in fact, obey just to sequencing criteria of the contents proper (e.g., lineal progression for the natural numbers firstly, whole numbers secondly, rational numbers thirdly, and real numbers fourthly.) It may also obey the nature of the contents (e.g., according to knowledge fields – firstly algebra, secondly geometry, etc.). However, it may also obey other progression models or systems: spiral, recurrent, problem solving, etc, or just following any other guideline. It may even be referred to criteria related to curriculum planning, and not to characteristics of the content itself, i.e., referred to specific aims related to more global or general aims of content acquisition.

Therefore, the design of the learning processes of each of the units, areas, modules or levels will have to include both the learning contents and the educational aims that are sought to reach in that unit, area, module or level.

Even if we sound repetitious, we should often remember that the sequencing of the learning contents has to refer to the three types of contents:
– facts, concepts and principles,
– procedures and algorithms, and
– attitudes, values and norms.

+ **Second.** Learning contents and skills for a certain module or subject will be developed and acquired by the student in an optimal situation, but the development and acquisition of other skills and contents that have not been planned will take place, or

maybe, some knowledge will have to be developed at a certain stage of the personal evolution of the student. Therefore, the **general objectives** of the unit or level in which we are working, connected with the three types of contents specified above, **should be oriented to the integral formation of all students.**

Therefore, when organising the task, i.e., when sorting and sequencing contents, we have to refer to the acquisition of the cognitive and psychomotor capacities, those of balance and personal autonomy, those of interpersonal and social relationships, all within the frame of the corresponding objectives for the unit.

In fact, learning contents should be part of the whole and full development of the student's personality; that is why learning contents and learning objectives should cover more formative aspects than those derived from the specific issues we are considering.

- **Third.** Accepting the **principles of meaningful learning** implies understanding the teaching-learning processes as part of the student's construction of knowledge.

    As we will see later on, **this assumption will particularly affect the orientations of the decisions taken in relation to the criteria which will determine the sequencing of the learning contents,** the teaching style, the selection of learning strategies and the selection of curricular material which would be most suitable for the students to have.

- **Fourth.** Our conception of formation demands, from the ethical point of view, that we design **teaching-learning processes that are adequately differentiated**, so that they would attend diversity in the students' capacities and interests.

    In fact, a formation that favours **attention to diversity** has to make sure all students acquire the basic contents. It also has to promote maximum development of each student, without any type of discrimination.

    This assumption implies an adequate distinction between what is basic and indispensable in learning and what is the result of enlarging or deepening a subject, this latter stage being available only for some students. Besides, the learning hierarchies should take into account the diversity in the students' starting points and the specific modalities in the acquisition of the different types of contents.

    Therefore, before sequencing the learning contents, we, as faculty, had better agree on these basic assumptions.

    If we all agree in four points mentioned above, then the team work will be smoother and more effective.

3. AIM OF THE SEQUENCING OF LEARNING CONTENTS

    The aim of sequencing contents is to establish a certain order within them that will ensure **the link between the educational objectives and the learning activities of the students**, in such a way that the organisation of the formative work guarantees the

realization of the formative interactions that are proper of the formative programme, of the educational community or of the institution.

We assume that the learning contents of a certain area are interdependent, and that the order in which they are presented is relevant to learning.

We will deal with three techniques to sequencing contents: the one based on content analysis, the one based on task analysis, and the theory of elaboration, which is the outcome of the attempt of combining the first two. This theory is highly recommended in the bibliography related to reform as guideline to learning sequencing.

However, before sketching the sequencing criteria inherent to the theory of elaboration, it will be relevant to scrutinise the specific contribution of each of the two mentioned techniques in order to point out some elements which can be of use in sequencing learning contents.

4. CONTENT ANALYSIS TECHNIQUE

In its most evolved stage, content analysis provides sequencing criteria that take into account both the internal structure of leaning contents and the cognitive processes that take part in meaningful learning.

No one doubts knowledge of the internal structure of ready-made knowledge makes comprehension and retention easier, and that it favours the learning continuity. However, the logical structure of knowledge, considered as starting point for the sequencing of learning activities, is not necessarily the best to facilitate students' learning. The main reason is that we cannot mistake the internal formal structure of a body of knowledge for the suitable structure that body is given in order to facilitate students' learning. That's why it is not enough to bear in mind the characteristics of the contents of the area or subject to be taught, but it is necessary to take into account the stage in which students are in relation to the learning of those contents and the way in which they will construct their own knowledge as a starting point.

Bearing in mind these considerations, and according to the Content Analysis Technique, the process to sequence a set of learning contents follows **three steps**:

1. **Discover and highlight the main axis** of the contents students should learn.
2. **Discover and highlight the main contents** and organise them in a hierarchical and relational structure.
3. **Sequence contents according to the principles of the psychological organisation of knowledge.**

According to J.D. Novak, the principles that rule the psychological organisation of knowledge can be summarised as follows:

1. All students can undertake meaningful learning provided they have relevant and inclusive concepts within their cognitive structure.

2. Learning contents should be ordered in such a way that general and inclusive concepts – i.e. main the main ones – are shown first. This favours the formation of more inclusive concepts in the cognitive structure of students, facilitating meaningful learning of other content elements later on.

3. In order to achieve a progressive differentiation of student's learning –i.e. the incorporation or new enriching and diversifying elements for the initial inclusive ones in the cognitive structure of students- and to achieve a later integrative reconciliation –i.e. coherence in the set of concepts in the cognitive structure- the learning sequences should be ordered from the general and advanced to the specific and particular.

4. After presenting the more general and inclusive concepts, the rest of the elements should be done by showing the relationships with the formers and among themselves. In this way, progressive differentiation and integrative reconciliation is facilitated.

5. The initial presentation of the more inclusive, general and important concepts should be illustrated with empirical concrete examples.

To sum up, content sequencing should be carried out taken into account **three general criteria** that will guide the organization of content for students' learning:

- **First Criterion:** The elaboration of learning sequences by the teachers assumes the consideration of the structure of the learning content to be proposed to the students as well as the may in which students build their own knowledge.
- **Second Criterion:** The contents chosen as fundamentals should be the most inclusive ones, i.e., the ones which can include other contents that students will also have to learn, and the more contents they can include the better.
- **Third Criterion:** More inclusive and general concepts should be presented before more concrete and irrelevant aspects.

With these criteria, following the three steps mentioned above, the analysis of the learning contents leads to the creation of conceptual hierarchies that suppose a top-down sequencing – more general and inclusive contents first and more specific last, through intermediate contents.

For the elaboration of learning sequences, in particular those related to concept contents, concept maps, tree representations, Venn diagrams, etc may be useful.

Those defects derived from the apparent rigidity of this type of sequencing can be avoided by cyclical presentation of contents, in order to trigger progressive differentiation and integrative reconciliation, emphasising the relationships among them.

This approach is fully compatible with a constructive interpretation of learning and of pedagogical intervention. The principles mentioned can be applied to all size of content sets, being equally valid for the different moments in the curricular design.

Anyway, our description has centred itself mainly and almost exclusively in concept contents. This is so because the valid criteria for content sequencing are referred only to relationships between concepts. Besides, it is not possible to reduce all learning contents to

concepts, and the mere attempt to do so will imply a serious damage to our compromise to whole education of our students.

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                          ┌─────────────────────────────┐
                          │ CONSTRUCTION OF CONCEPT      │
                          │ HIERARCHIES                  │
                          └─────────────────────────────┘
┌──────────────────┐      ┌─────────────────────────────┐
│ FIRST MOMENT     │──────│ Presentation of the         │────────┐
└──────────────────┘      │ MORE GENERAL CONTENT        │     ┌──────────┐
                          │ (more inclusive)            │     │ Relation │
                          └─────────────────────────────┘     │ ships    │
                                                              └──────────┘
┌──────────────────┐      ┌──────┐  ┌──────┐  ┌──────┐
│ Second moment    │──────│      │──│      │──│      │
│ (progressive     │      │      │  │      │  │      │
│ differentiation) │      └──────┘  └──────┘  └──────┘
└──────────────────┘      ┌┐ ┌┐    ┌┐ ┌┐    ┌┐ ┌┐
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│ Third moment     │      ││ ││    ││ ││    ││ ││   │ Relation │
│ (progressive     │      │└─┘│    │└─┘│    │└─┘│   │ ships    │
│ differentiation) │      └───┘    └───┘    └───┘   └──────────┘
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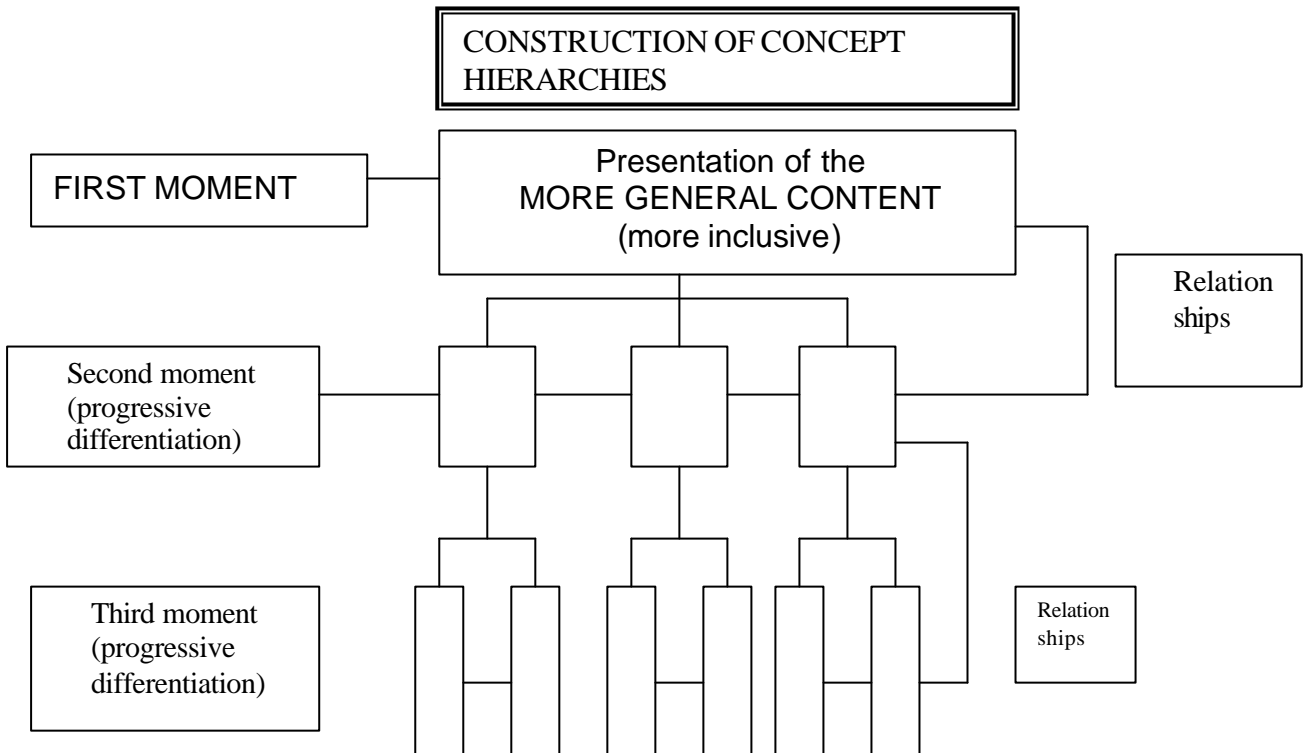
5. TASK ANALYSIS TECHNIQUE

Tasks analysis, that is, the setting and description of the activities (execution components that lead to the acquisition of a skill) is a technique that allows content sequencing in terms of expected outcomes in the students' learning.

In this approach, it is assumed that the handling of lower level intellectual skills implies more elementary learning processes than the handling of higher skills. The consequence is obvious: when a complex task can be divided into simpler or more elementary tasks that correspond to lower skills, these ones should be undertaken first, to go on to more complex ones.

In this frame of reference, learning contents are defined in terms of objectives of performances, which specify what the student should be able to do in relation to the learned contents. Therefore, for each set of contents, a set of tasks (objectives of actions) should be determined, and the actual performance of the tasks will imply the acquisition and domain of the corresponding contents.

According to these criteria, the terminal objective (evaluation criteria) will determine the intellectual skills that are necessary to reach it. These skills will imply simpler ones which will have to be learned, starting by the lower ones in hierarchy, i.e., those that match the initial capacity of the students and can be done with moderate effort.

According to Tasks Analysis Technique, the process to follow in order to sequence learning contents includes three steps:

1. **Determine the task the student should do** (skill to learn)
2. **Sub-tasks: determine the possible components or skills of the task** (subtasks or sub skills)
3. **Sequence subtasks or sub skills**, from the simplest to the most complex.

In the higher stages, task analysis is not limited to specify the action objectives and to determine de sequence of activities to be done, but it tries to identify the processes and the psychological structures that accompany the performance of the different activities, that is, it tries to show the specific competence corresponding to the performance of a specific task.

Therefore, task analysis attempts at discovering and explaining how people operate (the performed processes) with the data previously acquired (information) in order to solve a certain task (performance).

From this point of view, the sequencing of learning contents implies:

- To discover how to structure information in order to facilitate de performance of the task
- To determine the cognitive strategies and the procedures that should be applied for the performance of the task, that is, to the acquisition of the skill and learning of the corresponding content.

The task analysis technique is not developed enough so as to guarantee a correct and adequate sequencing of all learning contents and the corresponding learning process of the students, but it is useful to sequence some procedures that aim at the development of certain skills (intellectual, of handling, behavioural, etc.)

Some learning contents are adequate to be translated into a set of activities, but it is almost impossible in other cases, this is why it would be too risky to "translate" a whole set of contents (concepts, procedures, values,…) into tasks to be performed by students. There would be evident deficiencies in the results.

Therefore, sequencing applying just task analysis techniques based on learning hierarchies runs a twofold risk: on the one hand, it risks leaving aside important aspects of learning contents that cannot be translated into tasks. On the other hand, it risks not considering educational intentions that require more complex leanings.

6. ELABORATION THEORY

Elaboration Theory integrates elements from the Content Analysis Technique and from Task Analysis Technique within a coherent schema that attempts at improving their deficiencies. The result is a proposal of elaborative sequences as a way of sequencing learning contents.

The Elaborative Sequence is based on the following **principle**:

Leaning contents should be order so as to leave the more simple and general elements in the first place, and incorporating the more complex and detailed elements progressively later on.
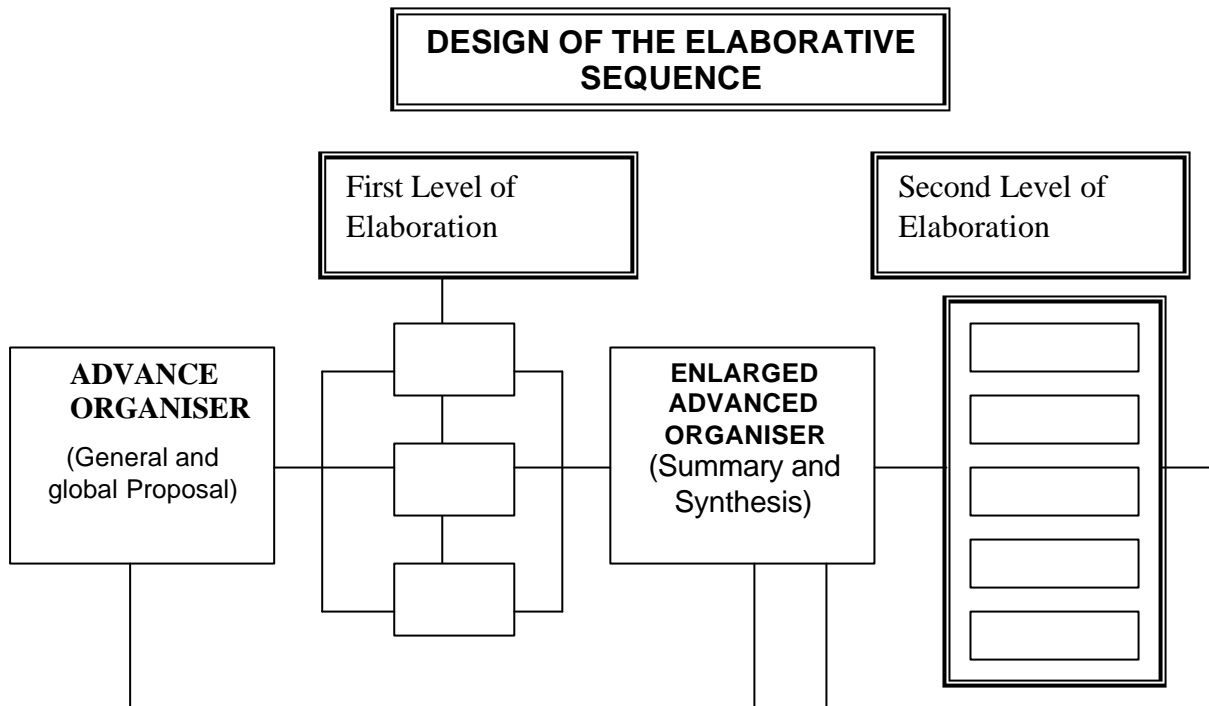
According to this principle, it would be advisable to present a global view of the main aspects of the learning content first, dealing with the elaboration of each part alone later on, and going back to the global view from time to time in order to enrich and enlarge it. In this way and once part of the initial view has been elaborated, in a first analysis stage, the starting point is resumed so as to place the elaboration in the global vision. Each part is dealt alike until all of them have reached a first stage of complexity.

The process can be repeated as many times as it's necessary until the desired stage of detail is reached. The aim is that the students can handle the learning contents in the complexity level that suits best their state of knowledge.

To sum up, the Elaboration Theory postulates that the learning results will be better from the qualitative and quantitative aspects when the organisation of teaching follows a model that:
- Presents the content that is the learning object in general and simple terms, within a general viewpoint
- Introduces the desired complexity level in each component of that global view and aims at incorporating the successive elaborations in it

The final stage of each of the elaboration stages requires that the elaborative sequence has a summary and a synthesis_ the summary includes a revision of the content elements that have been included in the corresponding elaboration level; and the synthesis shows the relationships that these elements hold among themselves and with others that are mere developments.

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│   DESIGN OF THE ELABORATIVE      │
│           SEQUENCE               │
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┌──────────────────┐                    ┌──────────────────┐
│ First Level of   │                    │ Second Level of  │
│ Elaboration      │                    │ Elaboration      │
└──────────────────┘                    └──────────────────┘
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┌──────────────┐         ┌─────┐         ┌──────────────┐         ┌──────────────┐
│  ADVANCE     │         └─────┘         │  ENLARGED    │         │ ┌──────────┐ │
│  ORGANISER   │         ┌─────┐         │  ADVANCED    │         │ ├──────────┤ │
│              │         └─────┘         │  ORGANISER   │         │ ├──────────┤ │
│ (General and │         ┌─────┐         │ (Summary and │         │ ├──────────┤ │
│ global       │         └─────┘         │  Synthesis)  │         │ └──────────┘ │
│ Proposal)    │                         │              │         │              │
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The Advance Organiser in the Elaborative Sequence

The epitome is the first step in the elaborative sequence. The epitome is a global view of the content.

The advance organisers are considered a very effective means to empower the student's cognitive structure, because they favour the retention of new information and help students to adequately interrelate the students' prior knowledge with the main elements of the new learning content.

Therefore, the advance organisers should act as bridges between the relevant concepts that are already present in the student's cognitive structure and the new contents to be learned. If there were not relevant concepts, the advance organiser would help the building of an inclusive concept that would, in turn, facilitate new learning.

The most effective advance concepts are those that use concepts, terms and propositions that are already familiar to the student and that can be easily presented through examples and analogies. The advance organiser has the following properties:

- It does not include all the important elements of the contents; just the most relevant and significant ones;
- Its elements are chosen in such a way that the rest of the content increases detail or complexity (the sequence goes from the general to the particular, and from simple to complex);
- The advance organiser should have a practical bias through examples, exercises or empirical illustrations in order to make it more meaningful to the student;

- The advance organiser and the elaborative sequence will have a certain content as a starting point which will also be the connecting thread along the sequence. This content can be attitudinal, conceptual or procedural.
- Those content elements that do not correspond to the main orientation will be introduced according to relevance in the overall learning process

Designing an Advance Organiser

According to Elaboration Theory, there are **three steps** in the design of an advance organiser for the sequencing of learning content.

1. **Choose the learning content** that can be used as advance organiser.
2. **Select the main and most representative elements** in the content
3. **Select other relevant elements** for the teaching or the advance organiser

The practical criteria suggested by the elaboration theory to design sequences of learning contents have an evident connection with the principles of meaningful learning, but are not enough, on their own, to orient all the decisions relative to sequencing, or cannot be applied in the same way to different types of learning contents. The operations implied in the process of sequencing contents in each curriculum area are complex, and the problems to solve in each case are not always easy.

Therefore, Elaboration Theory can be considered as valid as long as it guides as in the performance of a necessary task; but we cannot expect it to immediately solve every difficulty in the process of sequencing learning contents. In any case, it is fully compatible with the points set above.

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