The 4C/ID Model

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Introduction

As can we seen that nowadays the knowledge and skills needed to produce artifacts have changed radically. This is due to rapid changes in knowledge and technology. The crucial goal of technical education is to help students to acquire technical expertise (i.e. expertise to solve complex technical problems [Dale et al. 1990]). Recent instructional theories tend to focus on authentic learning tasks that are based on real-life tasks as the driving force for complex learning (Merrill, 2002). The general assumption is that such tasks help learners to integrate the knowledge, skills and attitudes necessary for effective task performance; give them the opportunity to learn to coordinate constituent skills that make up this performance, and eventually enable them to transfer what is learned to their daily life or work settings. This focus on authentic, whole tasks can be found in several educational approaches, such as the case method, project-based education, problem-based learning, and competency-based education. Van Merrienboer’s four-component instructional design model (4C/ID-model, 1997; van Merrienboer, Clark, & de Croock, 2002) describes how learning tasks fulfill the role of a backbone for an integrated curriculum (Figure 1: the “circles” represent learning tasks). Two requirements for this backbone are: (a) learning tasks are organized in easy to difficult task classes (the dotted boxes around sets of learning tasks), and (2) learners receive guidance for the first learning task in a task class after which support slowly disappears in this task class.

In a flexible curriculum, it should be possible to take differences between students into account. Some students are better able to acquire new complex skills or competencies and need therefore less practice and support than other students. In addition, elsewhere-acquired skills of new students should be taken into account. And complex skills or competencies are not coupled to separate courses or modules but developed throughout the curriculum or educational program, which makes it even more important to be able to select suitable learning tasks for students. In the 4C/ID-framework sketched above, this means that for each individual student, it should be possible to select the best task class to work on, and to select within this task class a learning task with the optimal level of support, at any given point in time. Electronic learning environments allow for such dynamic selection of learning tasks.

Overview

According to Merril (2002), the 4C/ID model is clearly problem-based although not in the sense of typical problem-based learning models (PBL). “At the heart of this training strategy is whole-task practice, in which more and more complex versions of the whole complex cognitive skill are practiced. While learners practice simple to complex versions of a whole task, instructional methods that promote just-intime information presentation are used to support the recurrent aspects of the whole task while, at the same time, instructional methods that promote elaboration are used to support the non-recurrent aspects of the task” (Merrill, 2002, p. 8-10).

van Merrienboer, et al., (2002) state that a Holistic Approach The 4C/ID model is a holistic design model and deals with complexity without losing sight of the separate elements and the interconnections between them. As such it is the opposite of atomistic design where complex contents and tasks are usually reduced to their simplest or smallest elements that can easily be transferred to learners through a combination of presentation (i.e., expository teaching) and practice. Using a holistic design approach solves three common problems in education, namely:

- compartmentalization - the tendency in traditional education to teach knowledge, skills, and attitudes separately;
- fragmentation – the tendency in traditional education to analyze a complex learning domain in small pieces, which often correspond with specific learning objectives, and then teach the domain piece-by-piece without paying attention to the relationships between pieces; and
- the transfer paradox - the tendency in traditional education to use instructional methods that are highly efficient to reach specific learning objectives (e.g., blocked practice), but that are not suitable to reach transfer of learning
The Four components Instruction Design

The 4C/ID model elaborated by van Merrienboer (1997) proposes four components to be considered in any design task: (1) learning tasks; (2) supportive information; (3) procedural information; and (4) part-task practice. Figure 1 depicts the framework of the four components.

![Diagram of the four components: learning task, supportive information, procedural information, and part-task practice](image)

Figure 1 Schematic representation of the four components: learning task, supportive information, procedural information, and part-task practice (van Merrienboer and Paas 2003, p. 13)

In the 4C/ID model (van Merrienboer 1997; van Merrienboer et al. 2002a; van Merrienboer and Paas 2003), learning tasks are authentic and meaningful real-life experiences that are provided to the learners. The learning tasks are typically performed in a real or simulated task environment, and they confront the learners with all constituent skills that make up a complex skill. The term ‘complex’, as used in complex cognitive skills according to van Merrienboer (1997), is used in the sense that the skills comprise a constituent set (integrated sets of knowledge and skills or recurrent and non-recurrent skills). At least some of those constituent skills involve conscious processing. The term ‘cognitive’, as used in complex cognitive skills, also indicates that the majority of the constituent skills are in the cognitive domain. In this regard, learning tasks allow for simultaneous practice of multiple learning goals (recurrent and non-recurrent constituent skills) so that students learn to coordinate those multiple learning goals. In other words, learning tasks allow simultaneous practice of domain-specific knowledge and cognitive strategies. Each of these components is described below.

Learning tasks

Learning tasks are the key component of the model. Concrete, authentic and meaningful whole-task experiences are provided to learners to promote the construction of cognitive schemata and enable the learners to achieve a desired learning goal. These tasks may take many different forms, such as problems, practice activities, case studies, projects and so forth. Learning tasks are organized in a simple-to-complex order, and these learning tasks are categorized by task classes, with a simpler version of the whole task serving as task class 1, a more complex version of the whole task serving as task class 2, and so on (van Merrienboer 1997, 2007; van Merrienboer and Kirschner 2007). For example, if the complex whole task involves conducting a search for literature on a given topic, a simple version of the whole task class would involve searching in a topic area in which the concepts are clearly defined, working with one database and employing only a few search terms, yielding a limited number of relevant articles. The more complex version of the task class would be a case in which concept definitions within the topic area are unclear, and in which full-text searches have to be performed in several relevant databases and with many search terms interconnected by Boolean operators, so to reduce the number of irrelevant articles likely to be identified (van Merrienboer et al. 2003).
As importantly, learning tasks within the same task class must show high variability in terms of the contexts or conditions in which the task has to be performed. For example, learning tasks for the literature search example may differ with regard to the field of study in which the search is performed and the bibliographical databases that need to be searched (van Merrienboer and Kirschner 2007). The reason for including variable learning tasks is to encourage learners to engage in “mindful abstraction” of schemas by focusing on the underlying deep structure of the problems, rather than on surface features that are often irrelevant to solving the task at hand (van Merrienboer et al. 2002). Several research studies have shown that variability of practice usually results in beneficial effects on transfer of training (e.g., Cormier and Hagman 1987; Shapiro and Schmidt 1982; Singley and Anderson 1989).

**Supportive information**

As the second component of the model, supportive information helps the learning of nonrecurrent aspects of learning tasks, that is, non-routine aspects that require reasoning and problem solving. This information, which is usually presented before learners start work in a particular task class, explains how to approach various types of problems within that class. For instance, an experienced researcher or instructor can describe his or her cognitive strategies or rules of thumb for converting research questions into relevant search terms (van Merrienboer et al. 2003).

**Procedural information**

Procedural information, the third component of the model, is necessary for learning recurrent constituent skills of learning tasks, that is, routine aspects that can be algorithmically performed according to domain-specific rules or procedures. This information, which is often referred to as just-in-time information, is usually presented in the form of step-by-step instructions that are presented to learners the first time they need to perform a particular constituent skill, and is only presented again if learners cannot recall it when they must apply the skill in subsequent situations (van Merrienboer 1997, 2007; van Merrienboer and Kirschner 2007). For example, a recurrent task in the previous example would be learner ability to compose search queries with Boolean operators. The first time they had to do so, learners would be presented with the step-by-step process for composing such queries. During subsequent instances, they would be told how to do so only if they requested that information (van Merrienboer et al. 2003).

**Part-task practice**

The fourth component of the model, part-task practice, may be necessary for selected recurrent constituent skills for which automaticity is desired. Part-task practice begins after the learner has practiced performing the whole task, so that the learner performs this additional practice activity within a context that is meaningful to him or her (van Merrienboer 1997, 2007; van Merrienboer and Kirschner 2007). For example, after learners practice how to search relevant literature, the instructor may provide them with part-task practice on using Boolean operators, so as to help learners achieve automaticity of that skill (cf. Carlson et al. 1989).

**Adaptive to Complex Learning**

Designing according to the Ten Steps, the table below presents for the four components the whole design process for complex learning, consisting of ten steps (van Merrienboer & Kirschner, 2007). These steps are typically employed by a designer to produce effective, efficient, and appealing educational programs.

As indicated in the right hand side of the Table, the four blueprint components directly correspond with four design steps: The design of learning tasks (Step 1), the design of supportive information (Step 4), the design of procedural information (Step 7), and the design of part-task practice (Step 10). The other six steps are auxiliary and are only performed when necessary. Step 2, in which task classes are sequenced, organizes learning tasks in easy-to-difficult categories. They ensure that students work on tasks that begin simply and smoothly increase in difficulty. Step 3, where performance objectives are set, specifies the standards for acceptable performance. They are needed to assess student performance and to provide them with useful feedback. Steps 5 and 6 may be necessary for in-depth analysis of the supportive information that would be helpful for learning to carry out the non-routine aspects of learning tasks. Analyzing cognitive strategies yields approaches that guide the learner’s problem solving processes in the task domain, and analyzing mental models yields those conceptual, causal, and structural models that help learners learn to reason in this domain. Steps 8 and 9 may be necessary for in-depth analysis of the procedural information needed for performing routine aspects of learning tasks. Analyzing cognitive rules yields condition-action pairs (IF condition THEN action) that allow learners to perform a procedure, and analyzing prerequisite knowledge yields facts, concepts, principles, and plans that learners should know in order to correctly apply their cognitive rules.
Table 1. Presents Ten steps to Complex Learning (van Merrienboer & Kirschner, 2007)

<table>
<thead>
<tr>
<th>Blueprint Components of 4C-ID</th>
<th>Ten Steps to Complex Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning Tasks</td>
<td>1. Design Learning Tasks</td>
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<td></td>
<td>2. Sequence Task Classes</td>
</tr>
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<td></td>
<td>3. Set Performance Objectives</td>
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<td>Supportive Information</td>
<td>4. Design Supportive Information</td>
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<td></td>
<td>5. Analyze Cognitive Strategies</td>
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<td></td>
<td>6. Analyze Mental Models</td>
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<tr>
<td>Procedural Information</td>
<td>7. Design Procedural Information</td>
</tr>
<tr>
<td></td>
<td>8. Analyze Cognitive Rules</td>
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<td></td>
<td>9. Analyze Prerequisite Knowledge</td>
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<tr>
<td>Part-task Practice</td>
<td>10. Design Part-task Practice</td>
</tr>
</tbody>
</table>

It should be noted that real-life design projects are never a straightforward progression from Step 1 to Step 10. New findings and decisions will often require the designer to reconsider previous steps, causing iterations in the design process. One may design a few learning tasks, in a process of rapid prototyping, before designing the whole educational program. And particular steps may be superfluous for particular design projects. As a result, ‘zigzagging’ between the ten steps is quite common. Then, it is the trick of the trade to keep a good overview of all – intermediate – design and analysis products as well as their relations to the ultimate training blueprint. Computer-based tools will be very helpful to carry out larger design projects, because they facilitate the systematic development of an educational blueprint and help designers to keep the required overview of the whole project – even when they zigzag between different design steps.

Conclusion

There are several reasons why the 4C/ID approach has been hypothesized as promoting better transfer performance. First, the model, by emphasizing whole-task practice, focuses on the integration and coordination of all the skills that constitute a complex cognitive skill and concurrently promote understanding (i.e., schema construction) of the complex skill. By doing so, the instructional program aims at transfer of learning—the ability to apply the complex cognitive skill in a wide variety of new real-life situations (van Merrieboer 1997, 2007; van Merrienboer and Kirschner 2007).

Another reason that the use of the 4C/ID approach is supposed to promote transfer of learning is because of task variability. As stated earlier, the learning tasks presented to learners should be highly different from each other, taking into consideration the many possible real world contexts that may be encountered by experts in the subject matter domain. This high variability of whole-task practice should enable learners to develop rich cognitive schemata, which should allow for schema-based transfer of learning (e.g., Paas and van Merrieboer 1994; Quilici and Mayer 1996; Schilling et al. 2003, van Merrieboer et al. 2006). As noted earlier, one of the primary purposes of this study was to examine whether such transfer would occur when the 4C/ID approach was used to teach learners a complex cognitive skill.

References


The 4C/ID Model hand-out

**What is it?** Four Component Instruction Design (Get it? 4C/ID) 4C/ID was created as a response to three deficits found in other instructional models and to teach complex skills. A few deficits found in other instructional models are:

1. Most instructional models focus on knowledge types, context or presentation-delivered media.
2. Lack of distinction between supportive information and just-in-time(performance required) information.
3. Use of either part-task or whole task practice.
4. Compartmentalizing information into separate areas.
5. Fragmenting information into small chunks without ever getting to the big idea.
6. Reaching education objectives without any knowledge transferred to the learners.

These deficits are overcome by the following tactics:

1. Using integration and performance of task-constituent skills.
2. Create a clear distinction between supportive information and just-in-time information.
3. Using part-task practice to support whole task practice.
4. Using a holistic approach to instructional design.

**The Four Components** The model has been broken into four tasks:

1. Learning tasks
   - concrete whole-task experiences
   - simple to complex task classes
   - high learner support in the beginning which lessens throughout instruction
   - high variability

2. Part-task practice
   - additional practice to reach automaticity
   - organized into sessions
   - snowballing and REP-sequences
   - practice rules with multiple applications

3. Supportive Information
   - supports at learning and performance
   - mental models, cognitive strategies, and feedback
   - each task support is specified
   - constant availability

4. Just-in-time information
   - created before learning occurs
   - displays, demonstrations, instances, and feedback
   - fits its skills
   - is available exactly when needed and then quickly disappears

Additional Info:

- The tasks are ordered according to difficulty
- As the learner progresses, the task complexity increases.
- The learner is ONLY supported by their increasing skills and just-in-time support
- The instructional designers goal is to identify correct skill requirements and create matching tasks for the skills
- The learner's goal is to solve increasingly complex problems without help. (Except for just-in-time support)

**Famous People**

- Jeroen van Merrienboer
  - http://edutechwiki.unige.ch/en/4C/ID
- Richard E. Clark
  - http://www.cogtech.usc.edu/publications/clark_4cid.pdf
- Marcel B. M. de Croock
- M. David Merrill
  - http://carbon.cudenver.edu/~mryder/ite_data/4cid.html
  - http://topics.scirus.com/Four_Component_Instructional_Design_4C_ID.html
  - http://topics.scirus.com/Four_Component_Instructional_Design_4C_ID.html