

# A model for the evaluation of learning styles design effectiveness

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## Abstract

*Assessing the customized system of a formative path, on the basis of cognitive styles, needs two fundamental requirements:*

- a) *the choice of a strong learning design model, built on conceptual maps, didactic objective trees and observable behaviours taxonomies (Bloom, Anderson, Romiszowski and Marzano);*
- b) *the utilisation of the Kolb Learning Style Inventory to evaluate the preferences individuals show in the learning context.*

*In the micro design phase each learning style is related to a different didactic strategy to manage the cognitive dissonance:*

- *Diverging: the negative case;*
- *Assimilating: the Quaestio;*
- *Converging: the Reductio ad absurdum;*
- *Accommodating: the linear simulation.*

*The activities performed to evaluate a traditional class sample compared to an on line course sample (WBT) are:*

- *the administration of the Kolb Learning Style Inventory to identify students learning styles;*
- *the class delivery based on the learning styles (differentiated according to the population sample of traditional and on line courses);*
- *the assessment of the I, II and III level learning effectiveness index in relation to the two kinds of course and the four learning styles;*
- *the administration of a Satisfaction Questionnaire;*
- *the calculation of the learning time (in traditional class and on line course as well);*
- *the efficiency calculation;*
- *the comparison between effectiveness and efficiency.*

*The research goal is verifying how the customisation of formative paths, based on students learning styles, can affect not only the formative effectiveness but also the efficiency in the learning design and the cost impact.*

**Keywords:** Learning Styles, Learning Effectiveness, Efficiency

## 1 Formative quality and micro design

Formative quality depends on many factors and involves different phases of the design process: from general strategy formulation to specific choices in micro design phases.

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Just in relation with the micro design phase, an experimental hypothesis will be here introduced: an applicative model has been designed to optimize and standardize decisional processes in order to define single strategies for several courses didactic units. Such model summarizes former design method – based on cognitive dissonance – and learning styles Kolb theories. Main goal is defining a micro design method, a reference theoretical frame and a precise procedure to assess the model itself and get the best formative quality.

## **2 Micro design dimension: complexity, cognitive styles and learning styles**

In micro design phase the most suitable strategy to single individuals has to motivate them to accept new input and get the course didactic objectives. This choice, crucial for creating storyboards and get satisfactory effectiveness levels, is based on three fundamental principles:

1. The didactic path must be perceived as useful, functional and suitable for user professional needs; which means formative contents must be calibrated on different complexity levels to get. This implies classifying contents complexity levels through a taxonomy allowing to interpret competencies features in five specific factors: (1) Four levels of Knowledge: Atomic mental models, Logic connection, Nomic relationships, Probabilistic connections; (2) Typology of Perception: Attention, Perceptive analysis, Perceptive synthesis; (3) Mnemonic process: Recognition, Recall; (4) Typology of Elaboration: Analysis, Synthesis, Evaluation, Creation; (5) Typology of Behaviour: Reproduction with support, Autonomous reproduction, Orientation to the objective, Strategic behaviour, Automonitoring (Bloom, 1956; Romiszowski, 1999; Anderson and Krathwohl, 2001; Marzano and Kendall, 2007).
2. The didactic path must generate a cognitive dissonance status in user's mind motivating him to research and select potentially consonant information, reduce dissonance and/or avoid information potentially increasing dissonance (Ronsivalle and Metus 2005). In 2004 a set of four plots has been designed to create differentiated storyboards and effectively manage cognitive dissonance.
3. The didactic path must adopt a formal model coherent with user learning styles.

Such principles and their detailed definition in building didactic units are a strong point in micro design phase.

## **3 Learning Styles Assessment**

Let's try to delve into the third principle.

Kolb distinguishes four different learning styles (or preferences) based on a four steps learning cycle, in which concrete experiences are observed and integrated in abstract concepts involving actions in order to create new experiences (Kolb 1984).

Ideally the process represents a learning cycle or a spiral where the subject tests, thinks and acts. The above-mentioned steps are: (1) Concrete Experience – (CE); (2) Reflective Observation – (RO); (3) Abstract Conceptualization – (AC); (4) Active Experimentation – (AE).

Experiential Learning is a process where constructing knowledge involves a creative tension among the four learning modes responsive to contextual demands (Kolb et al 1999).

Because of our hereditary equipment, particular life experiences and present environment demands, we develop preferred ways of choosing among the four learning modes. Kolb Learning Style Inventory - Version 3.1 (Kolb 2005) is used to assess individual learning styles. Each style is associated with a different learning approach (Diverging, Assimilating, Converging and Accommodating).

LSI is a useful tool to recognize uniqueness, complexity and variability in learning personal approaches. It can be used as a support to customise the learning design in strength of users learning styles.

If personal preferences have a stable nature, it's possible to hypothesize a formative path still unique but including the four learning styles.

#### 4 The path customisation

##### o Didactic strategies differentiation

In order to define motivation techniques with Kolb theory, four different didactic strategies have been linked to the learning styles to customise a class (traditional or on line as well):

Learning Style	Characteristics	Strengths	Educational Strategy	Scheme	Function
Diverging	Ability to take in information through concrete experience and processing it through observation. Imaginative ability to generate many alternative ideas	Brainstorming, feeling-oriented	Case study	Negative case	Involving through dissonant factors
Assimilating	Ability to abstractly take in new information and process disparate observations into an integrated rational explanation. Good at inductive reasoning and the creation of models and theories	Systematic planning, goal setting	Tutorial/ inductive	<i>Quaestio</i>	Involving through slightly dissonant factors
Converging	Ability to take in new information in the abstract and process it into a concrete solution. Hypothetical deductive reasoning get the best solution to a question or problem	Solving problems and making decisions	Tutorial/ deductive	<i>Reductio ad absurdum</i>	Defining the theoretical scenario
Accommodating	Ability to concretely take in new information and actively transform it, considering circumstances changes	Carrying out tasks, learning through practical experience	Simulation	Linear simulation	Simulating an interaction context, in order to get operative tools to reproduce the real world

Table 4 Learning Style-Didactic strategies Matrix

In our research, after analysing learning styles features we defined different educational strategies through Kolb Learning Styles Diagram, customizing the original version.

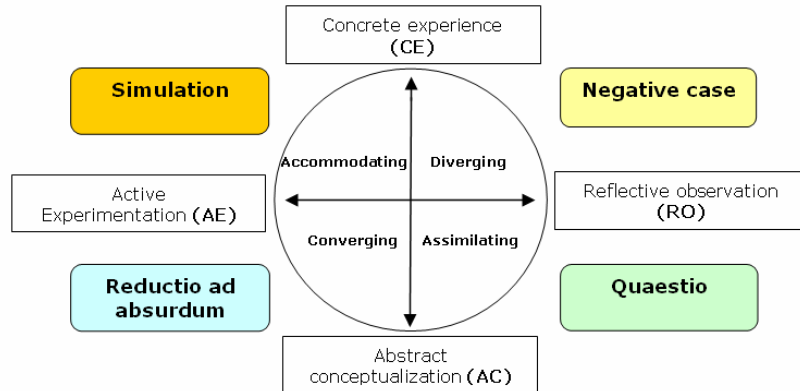


Figure 7 Educational strategies connected with Kolb Learning Styles Diagram

As subjects learn how to identify their personal learning styles, the hypothesis we bring forward is the customisation of the cognitive dissonance management, considering learning styles features.

Identifying learning styles can help manage cognitive dissonance and the resistance to learning: specific algorithms can actually optimize the learning effectiveness.

#### o Flexible micro-design cognitive styles oriented

In order to define a first laboratory session to test the model here introduced, a didactic unit has been micro designed about different effectiveness index levels (Ronsivalle *et al*, 2009; Ronsivalle and Donno 2009). The didactic unit, addressed to instructional designers, was structured as on line or traditional class as well.

Following contents, written according to four different learning styles, here describe the general formula to get the first level effectiveness index:

**Contents**

Effectiveness index ( $EF_1$ ) can be considered as the ratio between the actual **added value** (VA) and the **formative need** (FF):

$$EF_1 = \frac{VA}{FF}$$

Where **added value** VA results from the difference between final ( $SC_f$ ) and initial ( $SC_0$ ) competencies system :

$$VA = SC_f - SC_0$$

And **formative need** (FF) results from the difference between maximum attainable competencies level ( $SC_{max}$ ) and initial competencies system ( $SC_0$ )

$$FF = SC_{max} - SC_0$$

Here's the formula to calculate the **effectiveness index**:

$$EF_1 = \frac{VA}{FF} = \frac{SC_f - SC_0}{SC_{max} - SC_0}$$

Figure 8 Micro design contents

The underlying didactic objectives tree structure granted a unitary path, even if four didactic strategies were used as design modalities to get storyboard variations in relation with different learning styles. Following model principles every learning style can match with a specific learning strategy. Final results are four different cases.

### ▪ Negative Case oriented storyboard

In reference to the model, Diverging style (Concrete Experience – Reflective Observation) was associated to Negative Case and storyboard was structured as follows:

- page 1: general introduction of a negative case (in the given example building a training course) very close to students reality;
- page 2: further information were given to illustrate how to manage the problem;
- page 3: new information become necessary; to correctly solve the problem a formula to calculate the effectiveness index is described;
- page 4: interaction to allow student to identify Negative Case issues: resolution is possible only after considering the explained Theory.

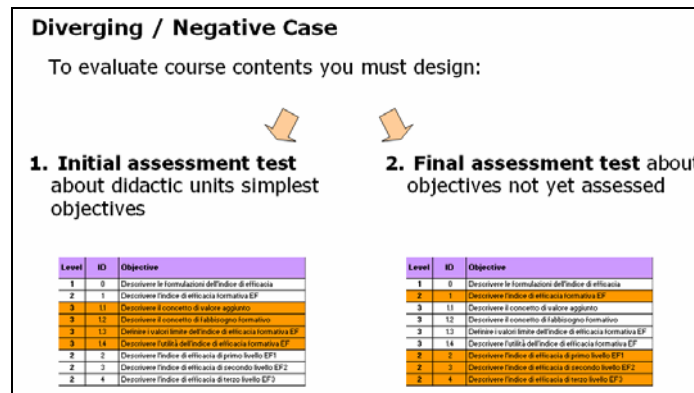


Figure 3 Negative Case oriented storyboard – Page 2

Student approaches the case in a concrete scenario. As external observer he can collect information, analyse the problem, summarize the theory and answer the interaction.

### 5 *Quaestio* oriented storyboard

Assimilating Style (Abstract Conceptualization – Reflective Observation) was associated to *Quaestio* strategy:

- page 1: the problem is introduced by some questions;
- page 2-3: a scheme defines elements to calculate effectiveness level;
- page 4: the index definition allows answering questions from page 1.

People learning by Assimilating Style understand and manage many information in a logical way: they're interested in abstract concepts and theoretical strength, more than practical application of a theory. In our case the didactic strategy was illustrating, through schemes and images, elements to define the effectiveness index.

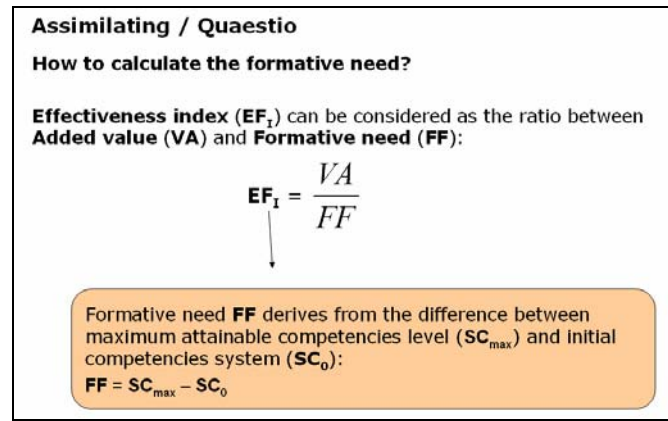
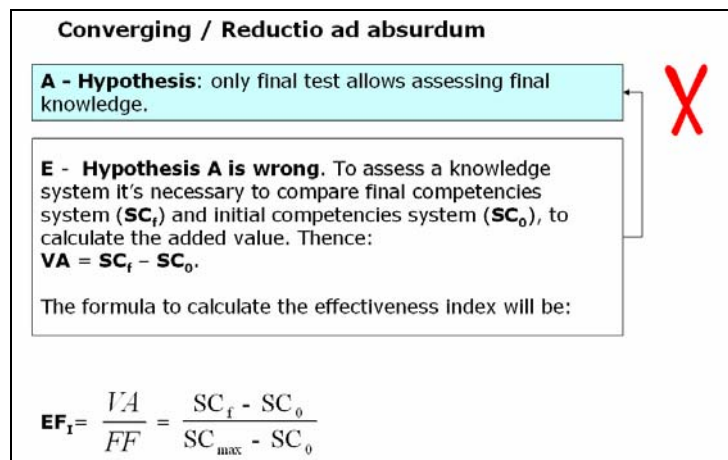


Figure 4 Quaestio oriented storyboard – Page3

## 6 *Reductio ad absurdum* oriented storyboard

Converging Style (Abstract Conceptualization – Active Experimentation) was associated to *Reductio ad Absurdum* strategy:

- page 1: an hypothesis A is introduced;
- page 2: an absurd conclusion is given;
- page 3: a new, correct hypothesis B is introduced (*tertium non datur*).

Figure 5 *Reductio ad Absurdum* oriented storyboard – Page 3

This strategy is suitable to people inclined to solve problems and make decisions by searching solutions. *Reductio ad Absurdum* consists of validating a theory/hypothesis through the falsification of the wrong theory/hypothesis. Analysing many solutions is more complicated but clearly suits such learning style the best.

## 7 Linear Simulation oriented storyboard


Accommodating Learning Style (Concrete Experience – Active Experimentation) is associated to a linear simulation.

- page 1: scenario introduction (student in charge of designing learning courses);
- page 2: step 1 objective (to calculate the course effectiveness index);
- page 3: step 1 interaction (to individuate the correct formula).

**Accommodating / Linear Simulation**

**Step 1**

Considering a competencies system SC, which variables are you supposed to measure?



<p>a) <math>EF_I = \frac{SC_f - SC_0}{SC_{max} - SC_0}</math></p> <p>c) <math>EF_I = \frac{SC_{max} - SC_0}{SC_f - SC_0}</math></p>	<p>b) <math>EF_I = \frac{SC_0 - SC_f}{SC_{max} - SC_f}</math></p> <p>d) <math>EF_I = \frac{SC_f - SC_0}{SC_{max} - SC_f}</math></p>
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**RIGHT ANSWER: B**

**Feedback:** Correct answer!/Wrong answer! Only if:

- the **Added Value** is considered as the difference between final (**SC<sub>f</sub>**) and initial (**SC<sub>0</sub>**) competencies system
- the **Formative Need FF** is considered as the difference between the maximum attainable competencies level (**SC<sub>max</sub>**) and the initial competencies system (**SC<sub>0</sub>**)

It will be possible to correctly calculate the course effectiveness index.

Figure 6 Linear Simulation oriented storyboard – Page 3

A simulation reproduces a concrete situation. In this “laboratory”, protected from external factors, user can test a “soft” version of his/her professional life, interacting with actors, context and observing his/her actions effects. People learning by this style are oriented to refer to their personal experience: the story is told in second-person narrative mode, user is the protagonist and every step represents a decisional moment.

## 8 Conclusions: Framework to meta-evaluate micro design model

The experimental validity of the hypothesis here introduced is related to some quality indicators, useful to evaluate the model suitability:

- 1° level index: the ratio between course added value and student formative need;
- 2° level index: allows pondering the general effectiveness taking into account the expected increase of knowledge/competencies homogeneity level;
- 3° level index implies considering learning time and includes a further correction factor in line with average and a priori expected learning time: higher the gap between the expected and actual temporal values, lower the 3° level effectiveness index;
- popularity rating consists of quantitatively composing a rank scale by analysing values in relation with variables such as users subjective perception;
- efficiency level derives from the ratio between production costs (including or corresponding to production time) and 3° effectiveness index level.

The experimental framework validating the model foresees the following procedure: (1) selecting among 100 people two isomorphic samples A and B, considering *LSI* administration results; (2) delivering contents by different learning styles strategies to users sample A; (3) randomly delivering contents to users sample B, not considering learning styles; (4) calculating quality indicators for each sample; (5) comparing the analysis of different results to establish best effectiveness and efficiency levels.

Verifying experimentally our model was a requirement to define a strong micro design tool in order to reconcile cognitive dissonance management techniques with students learning styles. The five dimensions taxonomy above introduced matches the model as the micro design strategic option is transversal to complexity levels. In fact, there's no direct relation among complexity levels (knowledge, perception, memory, elaboration and application), dissonance schemes and learning styles: the first ones are directly related to contents, the second ones depend on external variables and the last ones concern individual features.

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