

Sinsemia as a tool for designing interactive artifacts for teaching.

The case study of The topography of Dante's Inferno and the detailed definition of *reference frame*

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Abstract. “The Topography of Dante’s Inferno” is a synsemic interactive artifact which is designed for 11-14 years old students. The design process has been based on the fundamental concepts of synsemia, which lead to an artifact that includes and combines different didactic mediators; in particular, in this article is described more in detail the fundamental concept of *reference frame*. The reference frame can be described as the frame (consisting of graphic elements) which allows to contextualize the graphic elements of a synsemic text.

The artifact has been qualitatively evaluated in two focus groups (one with 12 teachers in training and one with 12 teachers in service), in which some reflections emerged, like some misinterpretations due to a more or less correct design of the reference frame and the didactic mediators.

Keywords: Synsemia, Didactic mediation, Context

1 Introduction

The project “The Topography of Dante’s Inferno” is a synsemic interactive artifact which is designed specifically for 11-14 years old students. After a research process, the website went under a first iteration of redesign and error-fixing.

As we described in two previous papers (Bonora et. al, 2017; Bonora et. al., in press), the project originated from the idea that there is no distinction between infographics, images and writing, which is the fundament of the theory of synsemia, which has a background in findings by Elkins, Goodman, Harris, Lussu (as discussed in Perondi, 2012).

The design of the artifact is based on the elaboration of the fundamental concepts of the synsemic writing (hereinafter described as the *synsemic quatrefoil*), as previously described in Bonora et al. (2017) and Bonora et. al. (in press). These four concepts are:

1. Visual variables
2. Dissociative variables (which define the visual hierarchy)
3. Associative variables (which define the aggregates of graphic elements)
4. Reference frame

In this article we describe further the concept of reference frame, which has its background in neuroscience theories, perception, cognition, learning, and the theory of affordances (Gibson, 2015, p.119; Kandel et al., 2013).

2 The Context. Background.

Starting from this definition we state that, in our perspective, the concept of reference frame is strictly related to the concept of "context". As Johnson (2014, p. 9) synthesizes, "the pattern of neural activity that corresponds to recognizing a letter, a word, a face, or any object includes input from neural activity stimulated by the context. This context includes other nearby perceived objects and events, and even reactivated memories of previously perceived objects and events."

Therefore, we consider the context as a complex integration of numerous elements (e.g. perception, memories, actions) which constitute a visual scene, a situation, a state of the memory, and this integration influences the perception and the analysis of an artifact and it contributes to assign meaning to the stimuli.

As already discussed by Perondi (2012, pp. 194-201) in an earlier stage, the context is created by the accumulation of memories and interaction with the artifacts and the environment. The recognition of an object implies the integration of the beholder with the environment in which the object lies (Gibson, 2015). As Kandel et al. (pp. 602-603) describe, the way in which a visual feature is perceived depends on everything that surrounds that feature and the response of a neuron in the visual cortex is context-dependent (e.g. the perception of a point or a line depends on how that object is perceptually linked to other visual features).

This form of embodied cognition (Varela et al., 1991, pp. 147-184) highlights how there is not a clear separation between vision and action, but rather there is a neural substrate which puts in relation the world with our possibility to act inside it. Indeed, Kandel (p. 557) explains how "In vision as in other cognitive operations, various features—motion, depth, form, and color—occur together in a unified percept. This unity is achieved not by one hierarchical neural system but by multiple areas in the brain that are fed by at least two major interacting neural pathways."

Indeed, the identification mechanism supported by the mirror-neuron system can be seen as a process aimed to understand the context, in which a subject

understands how to act and projects his/her actions in the environment (see for example Fogassi & Ferrari, 2007; Rizzolatti & Craighero 2004).

3 The Reference Frame as a *Portable Context*

All these reflections about the context can be applied to the synsemic writing, since the reference frame acts as an “activator” of neural pathways aimed to re-enact the context. The reference frames, which can be described as compressed contexts, are designed to be degraded in a systematic way with the goal of becoming “portable” – this hypothesis has been formulated and discussed by Luciano Perondi and Leonardo Fogassi during a personal interview (Fogassi, L., personal communication, June 27, 2017).

Creating a reference frame implies abstracting the context. The designer reduces the number of explicit relations within the elements of the context, stripping the context of its accessory references which are part of its complexity. This way, the designer compresses the context, making it become “portable” by reducing its informational “weight”.

The mode for creating a context is, in our opinion, similar to the one described by Weber for Ideal-Types (Swedberg & Agevall, 2016, pp. 156-158), for which the concepts are not made for copying the reality, but rather to highlight the connections which seems more relevant to the researcher. In this sense, the reference frame is the scheme which explicits the aspects that are considered more relevant by the author and the graphic compositor of the text. The readers also project a sort of “ideal type” on graphical artifacts, which is based on their expectations and previous experiences.

We hypothesize that neural pathways are activated by the reference frames though the process described as follows:

1. the set of visual elements, which are organized according to the synsemic quatrefoil, stimulate the reader’s elaboration of the context.
2. This context consist of a a set of relations between graphical elements aimed to highlight one or more specific aspects, which the author of the text considers relevant.
3. The set of relations stimulates in the reader the creation of the context which allows the interpretation of the artifact.

The design of the artifact through the usage of the synsemic quatrefoil—done by the author and the graphic compositor—as well as the interpretation of the quatrefoil—done by the reader—are not serial. The four components of the synsemic quatrefoil are to be designed and interpreted as parts of a single process. Therefore,

in the design of synsemic artifacts there is not a sequence of four distinct design actions, but a single process consisting of the integration of the four fundamental concepts.

When we refer to the reference frame, we do not refer to a cartesian grid—which is a particular case of reference frame—, but to a set of graphical-visual relations, and also proprioceptive, more or less regular, which allow to activate the elaboration of a more complex context.

The combination of the number of explicit relations within the reference frame and the degree of compatibility with the readers' "ideal-type" generates a perceived context. As consequence, the reference frame can be identified within a matrix scheme as follows:

Table 1. Description of reference frame types.

	High compatibility with the readers' "ideal-type"	Low compatibility with the readers' "ideal-type"
High number of explicit relations within the reference frame	Depictive	Impossible to disambiguate, inscrutable
Low number of explicit relations within the reference frame	Abstract	Hermetic

If the reference frame is depictive (high number of relations, high compatibility), the process of re-enactment (and decompression) of the context will be less subjective (more regular) and more immediate (less resource demanding).

If the reference frame is abstract (low number of relations, high compatibility), the process of reconstruction (and decompression) of the context will be more subjective (less regular) and more difficult to interpret (more resource demanding).

In case of low compatibility with the readers' ideal type, it can possibly happen that the reference frame results to be ineffective: the elements which are supposed to activate reconstruction (and decompression) of the context are not available to the reader.

Anyway, a synsemic text, even the more depictive, is a set of more or less complex relations, which are selected and ordered rather than being a copy of the reality.

Here it follows a series of examples which could help to better understand the concept of reference frame.



Fig. 1. Mercator, *Literarum latinarum, quas Italicas, cursoriasque vocat, scribendarum ratio*, Lovanio: Rutgerus Rescius, 1540.

Image retrieved from: <http://www.rarebookroom.org/Control/mcrlit/>

In this text from Mercator, the depiction of the arm acts as the main reference frame in order to explain the various aspects of “bona” and “mala gubernatio”. In this case the reference frame is based on a tridimensional representation, which helps the reader to elaborate the context of Mercator’s explanations. The typographical elements are activated and acquire meaning thanks to the reference frame “arm depiction”, which in turn becomes polarized and contextualized by the presence of alphabetic writings.



Fig. 2. John Ogilby, Strip map from the 1675 Britannia Atlas, showing the route from London to Bristol. Image retrieved from [https://commons.wikimedia.org/wiki/File:John_Ogilby_-_The_Road_from_London_to_the_City_of_Bristol_\(1675\).jpg](https://commons.wikimedia.org/wiki/File:John_Ogilby_-_The_Road_from_London_to_the_City_of_Bristol_(1675).jpg)

In this text from John Ogilby, the cartographic representation is distributed on a tridimensional paper strip, which is unfolded and weaves through the page. This expedient is aimed to elicit a context of continuous spatial representation, otherwise impossible since one of the geographic dimensions clearly prevails on the others. In this case, the tridimensional elements of the text provide the connections useful for contextualizing the various parts of the geographic map.

The paper strip is not colored, while the cartography is colored, and this allows to clearly distinguish the two main aggregates (paper strip and cartography). The tridimensional component (visual variable "orientation") intensify this distinction.

The compass roses, which are aggregated by the variables "shape", "color" and "size", are distinguished from each other by the variable "orientation", which allows to contextualize the geographical relations in the various parts of the cartographic representation.

From this example, it is evident that more reference frames (paper strip, compass roses...) can coexist and that those reference frames interact and attribute meaning to the elements of a synsemic texts.

In this article we report and discuss unpublished results from the previous research by Bonora et al. (2017). The aim of that previous study was to assess the potential effects of the usage of interactive synsemic artifacts in didactics. In particular, the results we present and discuss in this article are related to focus groups held with teachers in training and in service. The aim of this research was to investigate on the effectiveness of the design based on the synsemic quatrefoil and the recognizability of the used reference frames (e.g. the stratified funnel shape) from the teachers' point of view. The discussion was developed around the website "The topography of Dante's Inferno".¹

During the focus groups, the moderator asked to the teachers to express their opinions about the artifact in relation to its possible didactic usage.

4 Methodology

Here it follows a synthesis of the methodology used for the focus groups (which is described in more detail in the original article): two focus groups were held. One with 12 teachers in training, one with 12 teachers in service, both groups belonging to Department of Humanities at the University of Urbino. The website *Topography of Dante's inferno* was freely accessible to the teachers during the focus group. The teachers in training were prompted to discuss about the didactic features of the website and how they thought to use it in a school setting.

¹ The English version of the website is available at www.alpacaprojects.com/inferno/en/

The teachers in service were prompted to discuss about the purpose of the artifact, its possible didactic use and the usage and the role of educational mediators (regarding in particular the aspects of synsemic writing of the text). The focus groups were audio recorded and transcribed, coding the relevant conversational units and sub-units.

The documents containing the coded transcriptions are available (in Italian language) at:

1. Focus group teachers in training:
<https://drive.google.com/open?id=0B9XpaKxrMRP4SjZSUTZtT0dqbms>
2. Focus group teachers in service:
<https://drive.google.com/open?id=0B9XpaKxrMRP4RGZBZm5KaFZ4TVk>

5 Results

5.1 Results of Focus-Group Teachers in Training

The transcription of the focus-group with the teachers in training consists of 15 conversational units, for a total of 68 sub-units. From here the numeric references in parentheses denote units and sub-units of conversation.

From data analysis emerges that student reflections mainly focus on three topics: contents, didactic mediators, and knowledge adaptation.

The contents. Students (Teacher in training) show that they are interested to known content (1.1; 1.2; 3.3; 3.5). This interest is however "negative": they seem worried from the lack of expected content (the traditional scholastic contents, linked to the meaning of the poetic text, which they studied when they were at school). This could happen for two reasons. The first is a spontaneous adherence of the students to a "pedagogy of the content" (Develay, 1992). According to this concept, the pupil learns only through the perfect knowledge of the content by the teacher; the second is the students' acceptance of the "didactic contract", which is implicitly established in the didactic situation (Brousseau, 1998): within the didactic system, future teachers take the pose of students and feel obliged to demonstrate to the coordinator and members of the group their own knowledge of the Dante's poem. Concerns disappear when they realize that the artifact is intended to provide a representation of Dante's Inferno since. In this case, they should consider that the artifact can support the figurative and operational cognitive processes of students: understanding (2.4; 3.2; 5.6; 9.3; 9.6) and intuition (3.7; 4.2).

Didactic mediators. Students attribute specific importance to iconic mediators, linked to the use of figuration (5.7; 6.2); and active mediators, linked to the possibility of interaction with the artifact (5.6; 7.2). Instead, observations about the use of symbolic mediators, mainly linked to the use of alphanumeric text, are limited.

The adaptation of knowledge. Among the didactic transposition criteria, the criterion of “reduction to essential points is identified”.

The criterion is related to the selection of the scholastic contents which the educator aims to teach. The elements are “essential” if they structure the expert knowledge and if, at the same time, they constitute the points through which the educational path passes (Martini, 2011) (9.1, 9.3, 9.5, 14.3). Everyone agrees that the site allows for flexible teaching. The flexibility concerns both the kind of training courses (more or less linear) (11.2-11.7) and the type of student’s approach, in relation to their interests and characteristics (7.4; 10.2).

5.2 Results of Focus-Group Teachers in Service

The transcript of the focus-group with the teachers in service consists of 13 conversational units, for a total of 19 sub-units.

From data analysis emerges that teachers consider the topographic representation to be effective (1.1; 4.1; 7.1). In particular, the triangular/conical shape supports the understanding of the structure of the work as it allows to define and differentiate the various levels. The teachers also discuss the representation of the characters. Some are doubtful about the ability to recognize the characters because the images that represent them are not connotated enough. Others consider this aspect an advantage. Less detailed images could easily raise an otherworldly reality and provide a representation of punishments more suitable for boys aged 11-13 (3.1; 3.2; 9.1; 10.01; 11.1).

A teacher observed that there is no good balance between poetic text and images (8.1): *“the image does not help to decode the linguistic construct”*. These words suggest that he considers the image as a tool supporting the decoding of the individual line of poetry, like an illustrated paraphrase, and not as a graphic element integrated with others for understanding. In our opinion, this expectation could constitute an obstacle to teachers’ understanding of the concept of synsemia. The psychological function of images as learning support is well-known (Clark and Lyons, 2010). However teachers have little awareness of how different graphic elements interact with each other. They often think that the effects produced by more didactic mediators (alphanumeric text and images) coincide with the sum of the effects of individual mediators rather than with their combination.

Many teachers discuss about the didactic use of the artifact. They appreciate its flexibility to construct different didactic paths (1.1; 2.1) for the whole class (6.1). Finally, teachers believe that the artifact is effective in stimulating students’ curiosity and interest (4.1; 5.1).

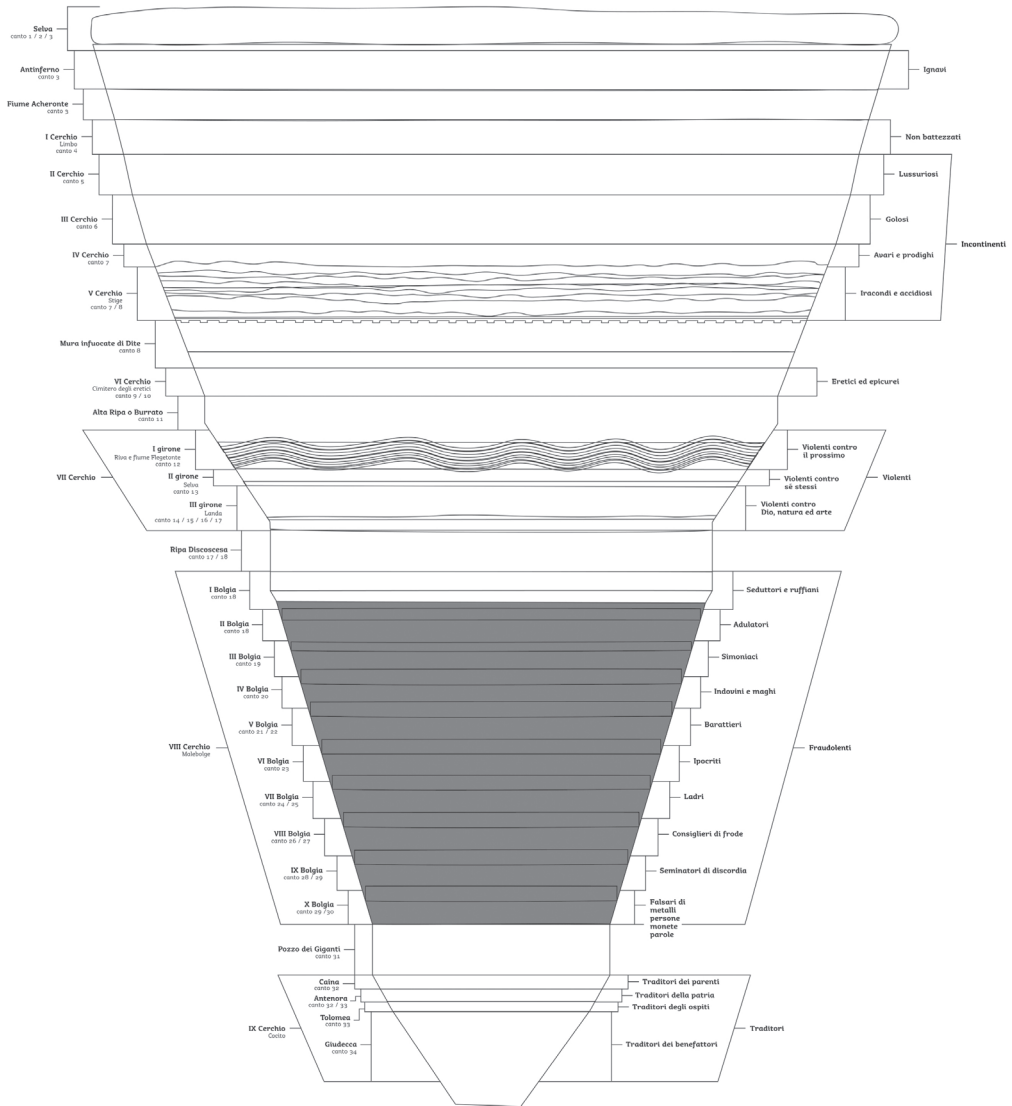


Fig. 3. The scheme of the funnel-shaped reference frame of the Topography of Dante's Inferno

6 Discussion

From the information collected during the focus groups, some reflections emerge:

1. Also in adults (and not only for the target young students) the presence of iconic mediators influences their perception of the hierarchical levels in the artifact: the funnel shape is an effective reference frame, which is understood, at least from the teachers.
2. While designing and using an iconic mediator or a reference frame, the designer needs to take into account the following bias: generating in the reader the expectation of an accurate and detailed transposition of the contents.

The readers create a context by means of the graphical artifact: what they see in the representation acquires a particular "truth value", for which they expect that all the elements in the artifact are planned and strictly consistent with the "contents". This is not possible obviously, but the writer (author and graphic compositor) needs to keep into account this readers' expectation, since every inconsistency in the composition through the synsemic quatrefoil can be interpreted as intentional by the reader: an artifact makes use of a reference frame, which activates a context, which in turn generates a sort of "expectation", which if it is not met it can generate confusion or suspiciousness about the usefulness of the artifact itself.

For these reasons, consistency and systematicity, or better the regularity (Greimas & Courtés, 2007, p. 280), are fundamental principles of the design of synsemic artifacts.

3. The teachers think that the process of the creation of knowledge originates from the sum of the didactic mediators used and not from their combination. This shows the preconceived belief that this process is linear (resulting from the sum of the mediators) and not non-linear (resulting from the combination of the mediators). This represents a didactic problem, since this belief suggests that the more the number of mediators, the broader is the comprehension, while an inappropriate combination of the mediators could generate a distortion in the comprehension and confusion.

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