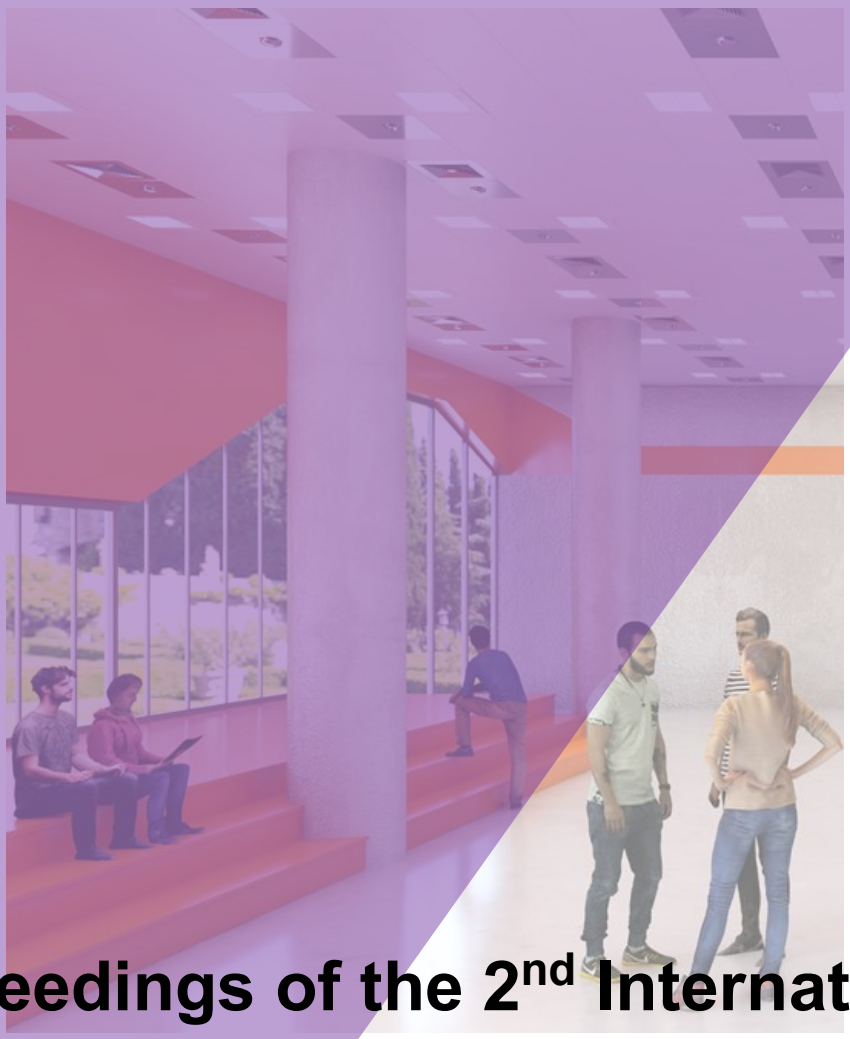


Proceedings of the 2nd International Conference of the Journal Scuola Democratica

REINVENTING EDUCATION

VOLUME III

Pandemic and Post-Pandemic Space and Time

ASSOCIAZIONE "PER SCUOLA DEMOCRATICA"

Page intentionally left blank

Proceedings of the 2nd International Conference of the Journal Scuola Democratica

REINVENTING EDUCATION

VOLUME III
Pandemic and Post-Pandemic Space and Time

ASSOCIAZIONE "PER SCUOLA DEMOCRATICA"

Via Francesco Satolli, 30 – 00165 - Rome, Italy

Edited by

The Organizing Committee the 2nd International Conference of the Journal Scuola Democratica

https://www.rivisteweb.it/issn/1129-731X

Published by: ASSOCIAZIONE "PER SCUOLA DEMOCRATICA"

Via Francesco Satolli, 30 – 00165 – Rome, Italy

Published in Open Access

This book is digitally available at:

https://www.scuoladem ocratica-conference.net/proceedings-2/

How to cite a proceeding from this Volume. APA citation system:

Author, N., Author, S., (2021). Title, in *Proceedings of the 2nd International Conference of the Journal Scuola Democratica "Reinventing Education"*, VOL. 3, *Pandemic and Post-Pandemic Space and Time,* pp-pp

ISBN 978-88-944888-9-0

Title **Proceedings of the Second International Conference of the Journal "Scuola Democratica" – Reinventing Education VOLUME III Pandemic and Post-Pandemic Space and Time**

This volume contains papers presented in the 2nd International Conference of the Journal "Scuola Democratica" which took place online on 2-5 June 2021. The Conference was devoted to the needs and prospects of Reinventing Education.

The challenges posed by the contemporary world have long required a rethinking of educational concepts, policies and practices. The question about education 'for what' as well as 'how' and 'for whom' has become unavoidable and yet it largely

remained elusive due to a tenacious attachment to the ideas and routines of the past which are now far off the radical transformations required of educational systems.

Scenarios, reflections and practices fostering the possibility of change towards the reinvention of the educational field as a driver of more general and global changes have been centerstage topics at the Conference. Multidisciplinary approach from experts from different disciplinary communities, including sociology, pedagogy, psychology, economics, architecture, political science has brought together researchers, decision makers and educators from all around the world to investigate constraints and opportunities for reinventing education.

The Conference has been an opportunity to present and discuss empirical and theoretical works from a variety of disciplines and fields covering education and thus promoting a trans- and inter-disciplinary discussion on urgent topics; to foster debates among experts and professionals; to diffuse research findings all over international scientific networks and practitioners' mainstreams; to launch further strategies and networking alliances on local, national and international scale; to provide a new space for debate and evidences to educational policies. In this framework, more than 800 participants, including academics, educators, university students, had the opportunity to engage in a productive and fruitful dialogue based on research, analyses and critics, most of which have been published in this volume in their full version.

ISBN 978-88-944888-9-0

Pandemic and Post-Pandemic Space and Time
A Premise

Papers in this third volume deals with the Covid-19 pandemic which is having an enormous impact on education systems worldwide. Policy makers, teachers, school managers, parents and students have been called to the reinvent their way of 'doing school'. At the same time, the governance of the education system and schools' organizations have been exposed to unprecedented tensions.

Within a short period of time, radical changes had to be introduced, simultaneously, at various levels of the school system. At national and regional level, there has been the need to rethink the way in which teachers are recruited, engaged and managed. National assessment and evaluation systems have been suspended or redefined in their uses by school actors The ways through which institutes were managed and organized had to be rethought, passing in a very short time through an on and off of dematerialization and hyper-normativity of time and space. Within schools, managers and teachers have been called to redefine the role of digital technologies in their didactic, as well as in their relationships with families and students. In some cases, these set of changes led to experience novel and unexpected daily proximities, in other prevailed a context characterized by distance and unsatisfactory relationships. Managers and teachers have been asked to re-invent their professionality to rethink their organizational, didactic and relational competences. Students and families, on their side, have been called to rebuild and reimagine new way of being at school, re-inventing the spaces and time of schooling and the way in which they relate among each other and with teachers.

The pandemic emergency has been a lens revealing intersections and structural tensions among various level and actors of the education system, but also allowing opportunities of changes thanks to the exogenous shock. At the same time, it must be considered that the emergency is interacting on pre-existing inequalities and contradictions. The pandemic clearly revealed the deep disparities of educational opportunities associated to students' life and housing conditions, beyond their access and uses of technological devices. Remote teaching and the enactment of an 'emergency didactic' has exacerbated learning difficulties for underprivileged students (children facing material deprivation, students with migratory background, students with special needs or disable, etc.). The interaction between the pandemic and pre-existing inequalities created different contextual conditions for actors' agency, orienting

toward different directions the pandemic's transformational potential.

Higher education systems have been affected too: in constant evolution due to constant transformations of society and changed functions of knowledge, universities have undergone a structural change along with pandemic times. Simultaneously, the growing relevance of knowledge for the economic development of the capitalistic system has profoundly affected higher education systems, characterized by the neo-liberal approach which his subject of increasing critical analysis.

However, Higher education systems are starting to be affected by other somewhat inevitable changing processes due to the evolution of knowledge and the consequent forms of its transmission. These forms have to be necessarily new both because of the availability of new instruments and the increased need to develop interpretative models of a constant and often unpredictable change. In this juncture the university might assume a renewed central role. At Higher Education System level, the growing use of digital instruments is envisaged in order to cope with the rising of the management rates of the training offer as well as to answer to the growing differentiation of user categories. A feasible consequence could be the increasing of the already pressure for the differentiation among the universities, with the related social implications.

At individual university level, it is foreseeable the demand for university involvement in tackling the problems of society and the economy will increase. And this at global, national and local level. From an organizational point of view the most significant feature is represented by the accumulation of traditional and new tasks that do not seem to be possible to manage. Whatever form the higher education systems will come to take, it remains that a central point to be clarified concerns the management of change. It will be the market that will impose its rules and the universities will organize themselves individually within the invisible enclosures that will guide their policies (with predictable growing social and territorial differences), or instead the State will choose incentive policies to direct its training system. It remains that in a condition of uncertainty and constant change the university's roles multiply and become – at least potentially – more and more central. It can therefore be argued that the university is not only called upon to respond to the demands of society but by elaborating answers and solutions to the problems it progressively affects the functioning of society.

We are fully aware that each educational experience produces specific results and definitions of teaching-learning practices. The well-established model of the magister teacher, based on a one-to-many transmission of knowledge, is complemented by new configurations of teaching-learning practices. There are

teaching practices that cultivate the ambition to combine the technological innovation with the psychological and pedagogical issues. Educational technologies, such as the Interactive Whiteboard, incorporate a new grammar and pragmatic in which the emphasis is placed on the involvement and the participation of the student, as well as on a “reverse teaching”, compared to the traditional one. The diffusion of online educational platforms, based on algorithmic architectures and data-driven approaches, also draws attention to a personalized way of learning and a datafication of teaching. Digital technologies are therefore stimulating a series of transformations in the socio-material order of the class affecting the spatial and temporal configuration of teaching. At the same time, they are embedded in the complexity of the educational contexts that rework their practical and symbolic value.

In the European framework of strengthening the relations between the labour market and education, we also witness the implementation of teaching practices associated with the idea of knowledge as an economic and social investment. Recently, a large field of critical investigation has highlighted how teaching aimed at improving the employment prospects of students is deeply affecting public values in education. At the same time, different points of view in the educational field claim to postpone the transmission of skills related to the labour market to broader educational objectives of social inclusion and civic participation.

The new proxemics imposed by the current pandemic challenge traditional spatial configuration, from the arrangement of desks to the mobile use of chairs, from the forms of communication in virtual environments to the interaction in the classroom. Therefore, this is to register the need to re-elaborate the ecology of the educational practices, starting from the socio-material space of learning.

Graphic Tools for a Visual Representation of the Curriculum

Luciano Perondi
Università Iuav di Venezia, lperondi@iuav.it

ABSTRACT: *By looking at the variables involved in the definition of the integrated curriculum as proposed by Martini (Martini, 2019), a visual representation can support the use and development of this model. A visual representation allows the readers not only to observe the relationships between elements, but also to highlight their criticalities and inconsistencies, in particular when relationships and variables articulate over several dimensions. Through visual representation the designer can arrange each variable both in a three-dimensional graphic space and to make use of other variables or visual attributes – such as color, shape, texture, etc. (Kepes, 1944; Bertin, 2011; Engelhardt, 2002) – to show further variables in a coherent manner, as long as there is an agreement between the variable represented and the visual attribute. The integrated curriculum itself is defined by Martini (2019) through graphic analogies. For example: « Conceiving knowledge as systems means thinking of them as aggregates of elements in a dynamic relationship between them, structured within them according to different levels of organization, in such a way that each of these levels corresponds to a supra- or a sub-system organized in the same way» (Martini, 2019, 6). Analogies bring together two abstract systems (Duhem, 1954), and visual analogies allow us to design a synoptically observable artifact with a heuristic value. A little further on, Martini proposes to use the network as a representational model of the structure of knowledge. Graphs are topological structures and they already show an isomorphic graphical representation of the properties they represent. The representation proposed by the author concerns the topology of the structure of knowledge, but it is possible to extend the representation to the other elements of the curriculum (identification of objectives, organization of time and space, the adoption of teaching methodologies, evaluation practices, the school-territory link and more), exploiting other graphic properties and integrating them with the graph of the knowledge structure. The first investigative work that needs to be conducted is to verify the regularity of the analogical relationship between the elements of the curriculum and their corresponding graphic form or if it is even possible to have an isomorphism between the graphic form and the object of the representation. Having verified the regularity of the analogy, it is necessary to develop a set of visual attributes that allow the variables of the integrated curriculum to be displayed consistently and systematically. The next step is to apply the visualization to a series of cases to optimize the set of graphic tools for the representation of the various levels and verify their functionality in terms of designing the curriculum itself.*

KEYWORDS: *Visual schematization, Synsemia, Integrated curriculum, Graphs, Diagrams*

Introduction

This paper is based on a paper by Martini (2019) in which, among other things, the author proposes the use of graphical tools (graphical/mathematical) to design and study the issue of the integrated curriculum. Martini bases her position on a strong analogy between graphs and knowledge representation. She refers in particular to graph theory and to the topological properties of the graph. Since she put the curriculum in analogy with the representation of knowledge, she proposes to adopt the graph as a model of the curriculum. She uses the visualization in the form of a graph both as a tool for observation and analysis, and as a design tool for the curriculum itself. By looking at the variables involved in the definition of the integrated curriculum as proposed by Martini (2019), a visual representation can support the use and development of this model.

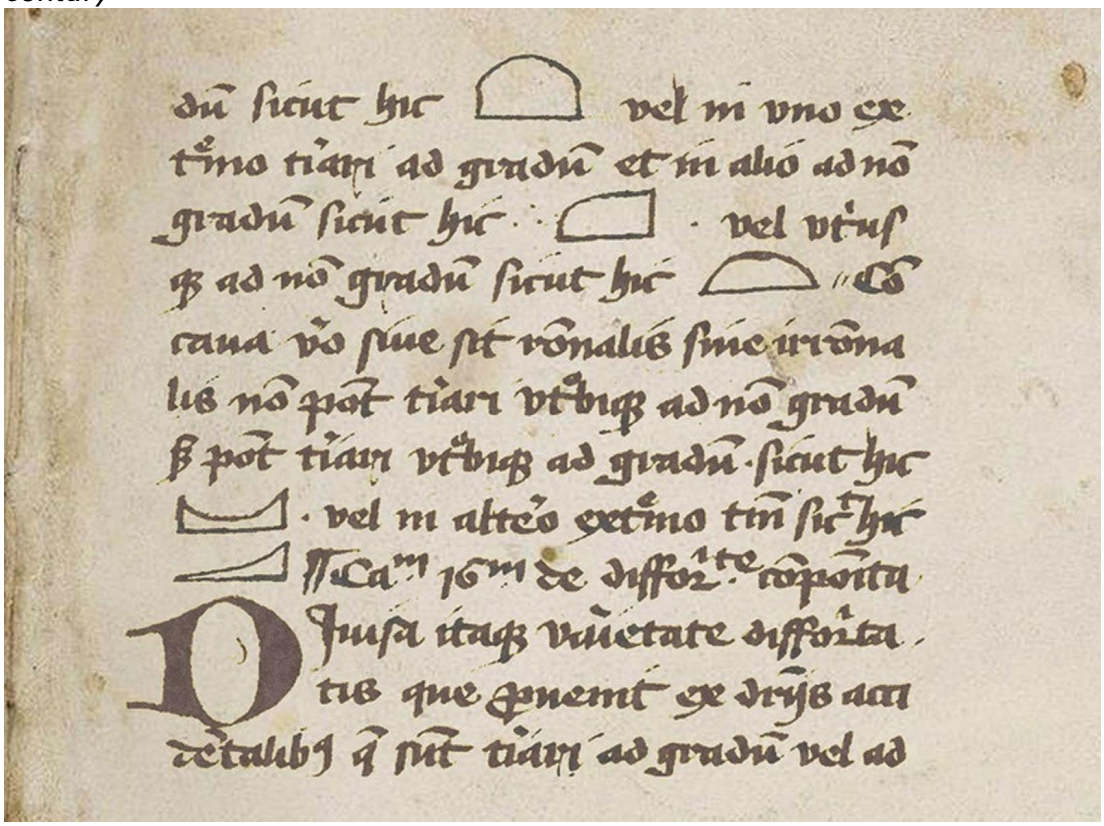
1. The representation knowledge as an instrument of knowledge

A visual representation allows the readers not only to observe the relationships between elements, but also to highlight their criticalities and inconsistencies, in particular when relationships and variables articulate over several dimensions. Several findings support the fact that the integration between image and 'written word' and the integration between linear text and schematization is effective in comprehension and memorization.

There is empirical evidence that organizing knowledge in graphic form and integrating linear text with diagrams can help comprehension and memorization (Butcher, 2006; Carney, Levin, 2002) and that this can have an impact on learning through an intelligent tutoring system (Butcher, Aleven, 2013). Visualization has shown its potential in supporting scientific research, multimodal writing has been used not only for explaining, but also to elaborate knowledge. Vertesi's observation (2014, 25) regarding the images of the soil of Mars: the planetary scientists manipulated the characteristic images so that otherwise invisible things emerged «that the point of their image manipulation was» to see new things, «to make a hidden feature» pop out, «to discriminate between different units that otherwise appeared the same in one filtered image». This can also be applied to anatomical representations, which work better as illustrations rather than photos, precisely because the illustration can more easily bring out a detail.

We can see the use of multimodal writing by Oresme (Fig. 1, among the first use of a coordinate bidimensional reference frame, that is a cartesian graph), but also in Galileo or Darwin sketchbooks, but also in Richard Feynman diagrams or DNA model. In questo senso non si può non osservare l'importanza che assume la dimensione visiva nell'esperimento mentale (Brown, 2011).

FIG. 1. *N. Oresme, Tractatus de configurationibus qualitatum and motuum, XIV century*

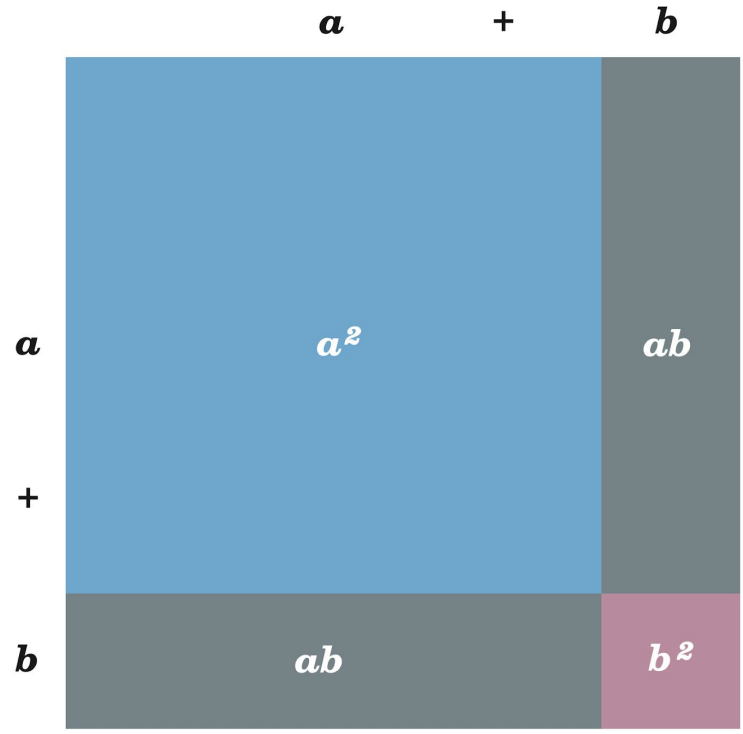


The image of Oresme's text is particularly significant as there is no solution of continuity between the alphabetical text and the diagram. The diagram is a substantial part of the argument. Each 'instrument' (i.e. linear writing and diagrams) is used for its own explanatory potential. The diagram allows us to observe the phenomena with a synoptic vision, without losing rigor and precision, but rather opening the way to what would have been the Cartesian diagrams and differential calculus.

2. Graphic tools for the design of a synsemic representation

It is necessary to consider the aspects related to the construction of a graphic system in order to design a coherent diagrammatic text, because the representation system needs to have a coherence with the depicted system. The goal is to seek the closest possible analogy, and if possible an isomorphism, between the object of the representation and the graphic form so that an operation carried out in the starting domain can be approximated in the closest way to that carried out in the domain of arrival (Perondi *et al.,* 2020). In mathematics, an isomorphism between the graphic form and the depicted object is possible in some specific cases, for example between geometry and arithmetic or even, for example, precisely due to graph theory.

FIG. 2. *Binomial expansion*



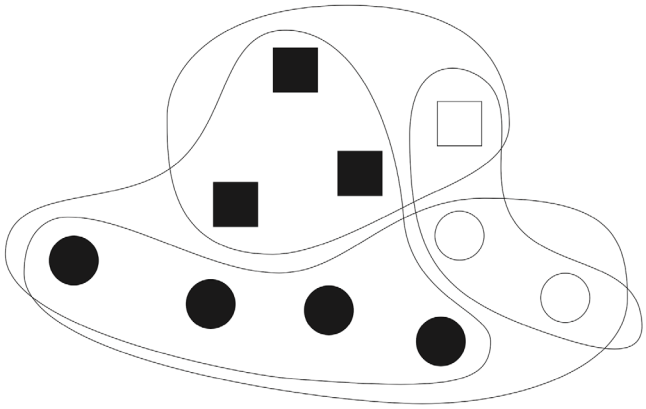
Source: drawing by the author

A very effective starting point to design a visualization with cognitive purposes is to adopt a taxonomy and 'tagging' the semantics of the content.

I have proposed, with other authors, to use a model that we have defined in previous essays as 'synsemic four-leaf clover' (Bonora *et al.*, 2019, 2020). The taxonomy we elaborated is intended to facilitate the design of a graphic artifact so that it is as consistent as possible with the object represented. This model is largely inspired by Bertin's taxonomy. Although there are other models and even if Bertin specifically dealt with statistical graphics, we argued that this model is effective in showing the logical relationships not only between visual variables, but also between elements and their hierarchical aggregations (horizontal and vertical) and the context of spatial relationships in which they are set. Through visual representation the designer can arrange each variable both in a three-dimensional graphic space, graphic space and to make use of other variables or visual attributes (Bertin, 2011; Kepes, 1944; von Engelhardt, 2002) – Bertin listed size, tone, texture, colour, orientation, shape and position – to show further variables in a coherent manner, as long as there is an agreement between the variable represented and the visual attribute.

Visual variables (or features) are the first leaf of synsemic quatrefoil. They correspond to the semantic variables. The visual variables can be associative (Fig. 3), and in this case we have sets of similar objects. These sets correspond to the semantic aggregations defined by the designer and are the second petal of the four-leaf clover.

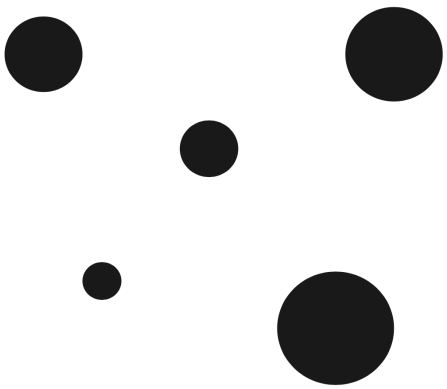
FIG. 3. *Associative variables*



Source: drawing by the author

The visual variable can be dissociative (Fig. 4), whereby the elements are arranged in a hierarchical order. The hierarchy is the third petal.

FIG. 4. *Dissociative variables*



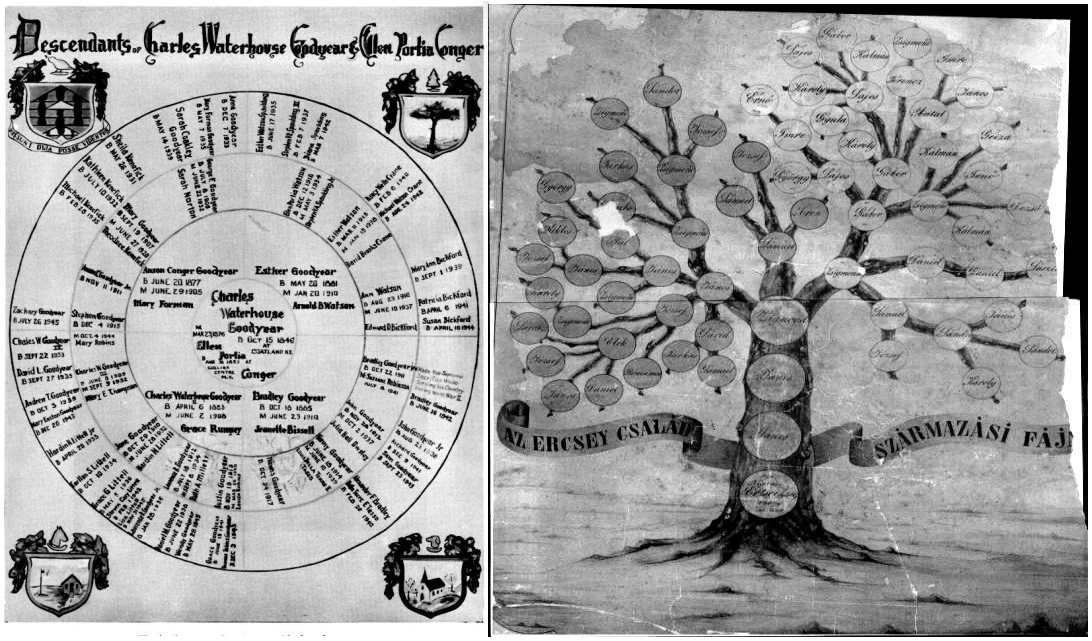
Source: drawing by the author

The visual properties of the variables, according to Bertin (2011, 48), 'impose' a precise relationship between the graphic elements that must reflect the semantic relationship of the objects represented, otherwise the risk is that a sort of 'stroop effect' occurs.

The fourth petal is what we have called the 'reference frame'. The reference frame is what gives meaning to the space: if we look at the

pictures in Fig. 5, we notice that the different arrangement of the basic information may generate a completely different reading of the same data.

FIG. 5. *Circle generation chart and family tree*



Source: unknown authors, available on: http://freepages.genealogy.rootsweb.ancestry.com/~mcclendon/Bogalusa/Bogalusa%20Story/BogalusaStory-with-photos.html

On one side we see a family tree, on the left a circle generation chart. The tree allows us to better read the information in a sequence of 1 to 1 relation, the circle chart allows us to better read the structure of the family and the relationship between distant elements (such as parental link, generation, etc.).

Different spatial arrangements allow different points of observation, and help in a different way heuristic processes.

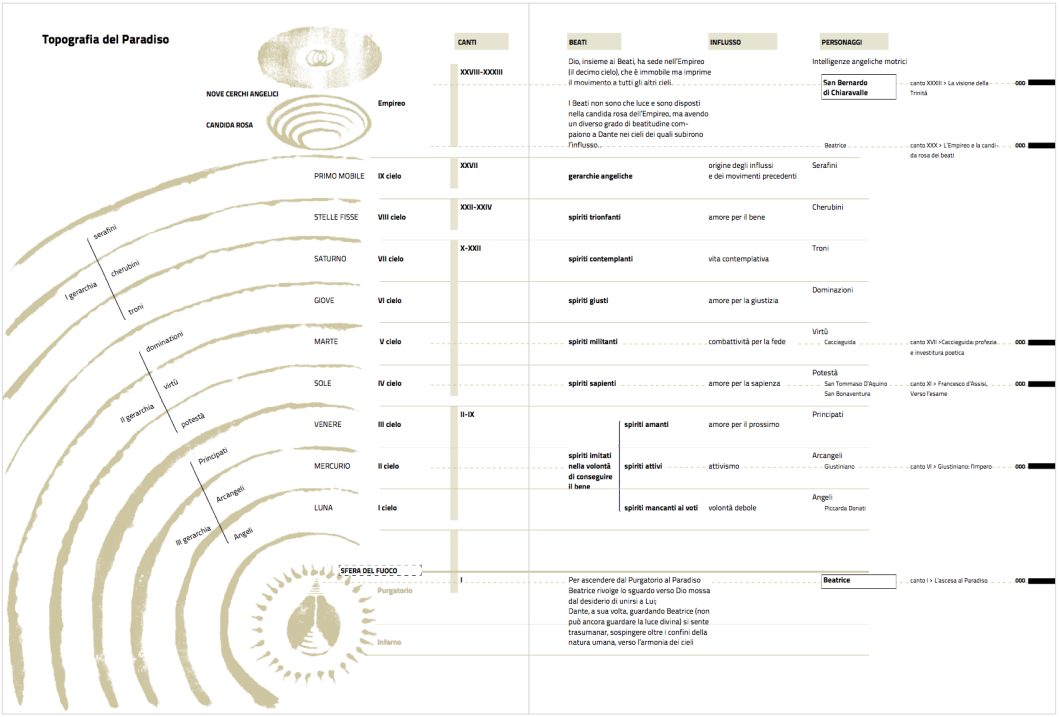
Reference frames are therefore the set of relations in a graphical artifact that give meaning to the space.

> 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 reference frame is the scheme which explicits the aspects that are considered more relevant by the author and the graphic compositor of the text. (Bonora *et al.,* 2020)

The strength of a visual representation allows the readers not only to observe the relationships between elements, but also to highlight their criticalities and inconsistencies, in particular when relationships and variables develop over several dimensions.

Different reference frames can be used to represent the same data, and each view, as long as it is consistent, will reveal a different way of accessing knowledge.

FIG. 6. *Dante's Paradise topography*



Source: Drawing by Angelo Monne, Luciano Perondi, Illustrations are part of the anthology Antologia della Divina Commedia. Incontro con l'opera. Beatrice Panebianco, Cecilia Pisoni, Loretta Reggiani, Marcello Malpensa. Bologna, Zanichelli.

If we observe Fig. 6, we note how the right and left side of the representation show the canticle of Paradise according to two completely different perspectives, each of them highlights different aspects through different graphic features. The connection between the two sides is the visual variable 'position'.

Analogy is the foundation of this process. Analogies bring together two abstract systems (Duhem, 1954), and visual analogies allow us to design a synoptically observable artifact with a heuristic value.

3. The diagrammatic representation of the integrated curriculum.

The integrated curriculum is defined by Martini (2019) through an analogy. She put the curriculum in analogy with the representation of knowledge on the basis of the acquisitions of network science (Barabási, Oulx, 2004; Buchanan, 2003). This operation is possible because (Martini, 2019) knowledge is conceived as complex systems which in turn can be represented by networks (Bertalanffy, 2004; Capra, 2012; Luhmann, De Giorgi, 1992).

The first investigative work that needs to be conducted is to verify the regularity of the analogical relationship between the elements of the curriculum and their corresponding graphic form or if it is even possible to have an isomorphism between the graphic form and the object of the representation.

In an isomorphism, the operations performed in one domain are also valid in the other, the connection is one-to-one. Unfortunately, the known isomorphisms are very few.

In an analogy the connection is less strong (Hesse, 1980), so the reader must be well aware of the limits of the analogy adopted. Otherwise, the reader will be able to apply the analogy as if it were an isomorphism and to use the relationships identified in a domain as a reliable inferential tool.

As I illustrated in another paper (Perondi *et al.,* 2020), the analysis of an analogy can have a heuristic function even if there is not a perfect biunivocal relation, but the reader must be well aware of the limits of the analogy itself. Having verified the regularity of the analogy, it is necessary to develop a set of visual attributes that allow the variables of the integrated curriculum to be displayed consistently and systematically.

> Conceiving knowledge as systems means thinking of them as aggregates of elements in a dynamic relationship between them, structured within them according to different levels of organization, in such a way that each of these levels corresponds to a supra- or a sub-system organized in the same way (Martini, 2019)[1]

Here Martini identifies associations between elements (associative variables) and a hierarchy between levels (dissociative variables), which are organized according to composition rules (reference system). A little further on, Martini proposes to use the network as a representational model of the structure of knowledge. Graphs are topological structures and they already show an isomorphic graphical representation of the properties they represent.

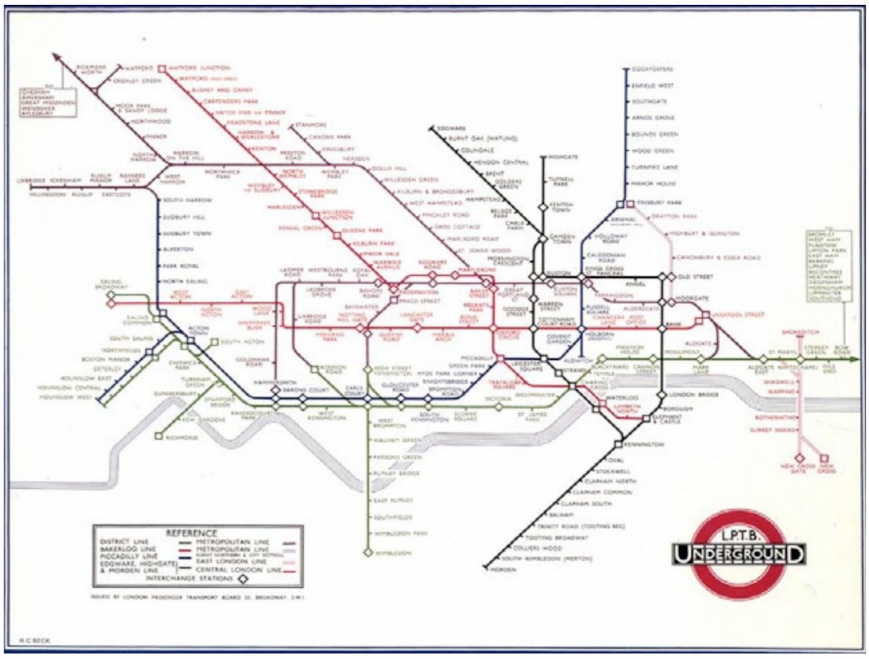
A graph would produce an orderable graph, as its property is to consider the relationship between nodes, but not the distance.

The representation proposed by the author concerns the topology of the structure of knowledge, but it is possible to extend the representation to the other elements of the curriculum (identification of objectives, organization of time and space, the adoption of teaching methodologies, evaluation practices, the school-territory link and more), exploiting other graphic properties and integrating them with the graph of the knowledge structure. For example, we can hypothesize that we can give a meaning to the length of edges that connect the nodes, or to the position of the nodes themselves, and the graph would turn into a quantitative

[1] Original text (Italian): «*Concepire i saperi come sistemi significa pensarli come aggregati di elementi in relazione dinamica tra loro, strutturati al loro interno secondo diversi livelli di organizzazione, in modo tale che ciascuno di questi livelli corrisponda ad un sovra- o ad un sotto-sistema organizzato allo stesso modo*» (Martini, 2019).

visualization, which would reveal other aspects of the curriculum. Let's take the example of the London Underground Map (Fig. 7). The same information can be transformed based on the reference frame adopted and the variables that you choose to highlight.

FIG. 7. *London Underground Map, designed by Harry Beck*



Source: Government of the United Kingdom. This map is in the public domain.

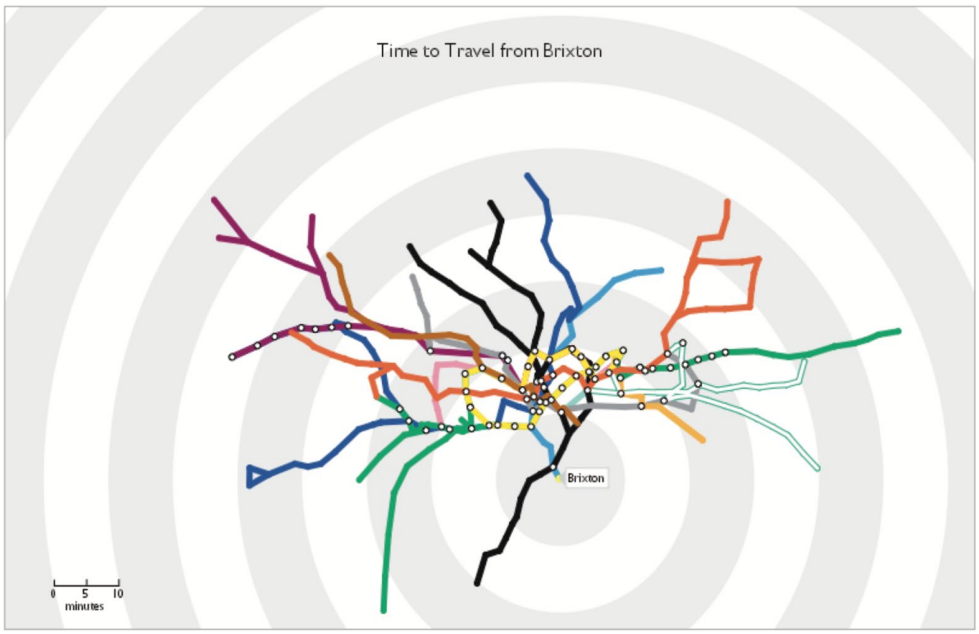
If we give a geographical value to the nodes, they will be arranged as in Fig. 8.

FIG. 8. *London tube map based on a geographic projection*

Source: retrieved from https://commons.wikimedia.org/wiki/File:London_Underground_full_map.png

In Fig. 7 we have a sort of graph, like in graph theory, with nodes and edges, but with a 'rule of composition': the edges can have just three possible orientations (vertical, horizontal and 45°). The information is again different: it's possible to arrange in a small space a defined information, keeping just what you need in a trip on the underground: the sequence of stations. And this one is more or less the map which is still used now, as it is probably the most ergonomically efficient in the geographical environment of London.

FIG. 9. *London interactive time to travel map*



Source: retrieved from www.tom-carden.co.uk.

In Fig. 9 we can see a 'time to travel' map, where the reference frame is no more the geographic space but time and direction: different reference frames generate different graphic configurations, each one of them generates different information.

Each configuration suits well for a specific purpose. A representation can be understood as an intentional act (Giere, 2004, 2010; Tombolato, 2020) in which those who make the connection between object and representation select the features to be highlighted. If we try to do the same operation with the curriculum, we could increase the 'attractive power' of knots with more 'fitness', creating meaningful variation of density. This is a redundancy, but in this way the Clusters would be systematically highlighted.

The nodes with more fitness could also have a higher dimension or a darker tone based on the number of fits, creating a hierarchy based on the dissociativity of the variables.

Another possibility is to arrange the elements in bidimensional space, for example, as Martini herself indicates, according to the propaedeuticity or to the logical inclusion. The different disciplines could be arranged on

another axis, in order to highlight the disciplinary aspects and the weak links that connect aggregates of knowledge in different disciplines.

This operation obviously transforms the graph into a different object, since it would assume a quantitative or at least ordinal dimension. See for example the diagram on the right side in the schematization of paradise that I made with Angelo Monne in Fig. 6.

It is possible to work at the design of an integrated curriculum on the basis of relationships highlighted by the graphic visualization. By developing a system that dynamically responds to interventions, we could observe the effects that changes in the pathway have on the overall visualization itself. Dynamic visualization could be the feedback of curriculum design operations.

I have no evidence that the visualizations I have illustrated can favor knowledge processing, but I believe that empirical evidence on the subject relating to understanding graphs (Strobel *et al.,* 2018) and multimodal reading (Canham, Hegarty, 2010), show an advantage dependent on the integration between different diagrammatic and textual modes. Although a switch between different modalities can have negative effects (Cromley *et al.,* 2021).

The next step is to apply the visualization to a series of cases to optimize the set of graphic tools for the representation of the various levels and verify their functionality in terms of designing the curriculum itself. This will allow us to carry out empirical experimentation on the effectiveness in terms of comprehension and heuristic function of the use of diagrams in the processing of knowledge. For example, we could verify if the use of two Cartesian axes lowers the threshold of access to comprehension, or if the highlighting of the greater degree of fitness through the attribution of a greater 'gravitational attraction' to objects impacts on understanding and on the ease of use of the diagram. Or again if the redundancy between tone and gravitational attraction is functional to a greater perspicuity of the diagram.

Conclusion

The aim of this paper is to propose educators to use a wider set of graphic instruments which support the representation of the curriculum. I provide examples to show how the interaction between synoptic representation and knowledge organization can be functional to educators to elaborate on the problems concerning curriculum development from multiple and more interactive perspectives.

I see a huge potential in elaborating dynamic schematizations and in the possibility of synsemic configurations of the scientific text, such as visual abstracts (Ibrahim *et al.,* 2017; The art of abstracts, 2011), that we can apply to didactics.

The instruments for processing schematic and diagrammatic views are increasingly refined, as are the instruments for investigation and analysis

of usability and cognitive performance. It is therefore necessary to give an empirical foundation to the presumed heuristic effectiveness of the use of diagrams and synsemic and multimodal texts. I think that an area in which the subject of discussion involves the study of a flexible system with a variable topology allows us to test the effectiveness and perspicuity of a diagrammatic organization of contents. This operation can bring benefits both for the development of more effective graphic instruments for the development of knowledge, and for creating instruments to support the design of the integrated curriculum and therefore a functional instrument for addressing education problems.

References

Barabási, A.L., Oulx, B. A. (2004). *Link: La nuova scienza delle reti*. Turin, Einaudi.

Bertalanffy, L. (2004). *Teoria generale dei sistemi*, Milan, Mondadori.

Bonora, G., Dalai, G., De Rosa, D., Imperato, A., Martini, B., Perondi, L. (2020). «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», *2CO Communicating Complexity. Contributions from the 2017 Tenerife Conference*, 94–104.

Bonora, G., Dalai, G., De Rosa, D., Imperato, A., Perondi, L. (2019). «Dante's Inferno», *Proceedings Vision Plus 2017: Core Competencies – Information Design in Education*, https://www.iiid.net/PublicLibrary/VisionPlus-2017-Riga.pdf

Brown, J. R. (2011). *The laboratory of the mind: Thought experiments in the natural sciences*. London, Routledge.

Buchanan, M. (2003). *Nexus. La rivoluzionaria teoria delle reti*. Milan, Mondadori.

Butcher, K. R. (2006). «Learning from text with diagrams: Promoting mental model development and inference generation», *Journal of educational psychology*, 98 (1), 182.

Butcher, K. R., Aleven, V. (2013). «Using student interactions to foster rule–diagram mapping during problem solving in an intelligent tutoring system», *Journal of Educational Psychology*, 105 (4), 988.

Canham, M., Hegarty, M. (2010). «Effects of knowledge and display design on comprehension of complex graphics», *Learning and instruction*, 20 (2), 155–66.

Capra, F. (2012). *La scienza della vita*. Milan, Bur.

Carney, R. N., Levin, J. R. (2002). «Pictorial illustrations still improve students' learning from text», *Educational psychology review*, 14 (1), 5–26.

Cromley, J. G., Kunze, A. J., Dane, A. (2021). «Multi-text multi-modal reading processes and comprehension», *Learning and Instruction*, 71.

Duhem, P. (1954). *The aim and structure of physical theory*.

Giere, R. N. (2004). «How models are used to represent reality», *Philosophy of science*, 71 (5), 742–52.

Giere, R. N. (2010). «An agent-based conception of models and scientific representation», *Synthese*, 172(2), 269–281.

Hesse, M. B. (1980). *Modelli e analogie nella scienza*. Milan, Feltrinelli.

Ibrahim, A. M., Lillemoe, K. D., Klingensmith, M. E., Dimick, J. B. (2017). »Visual Abstracts to Disseminate Research on Social Media: A Prospective, Case-control Crossover Study», *Annals of Surgery*, 266 (6).

Luhmann, N., De Giorgi, R. (1992). *Teoria della società*, Milan, Franco Angeli.

Martini, B. (2019). «Verso un modello di curricolo integrato», *Pedagogia più Didattica*, 5 (2).

Perondi, L., Ferrari, M., Ricci, D. (2020). *A dictionary of visual analogies*. Universidad de La Laguna.

Strobel, B., Lindner, M. A., Saß, S., Köller, O. (2018). «Task-irrelevant data impair processing of graph reading tasks: An eye tracking study», *Learning and Instruction*, 55, 139–47.

The art of abstracts, (2011). *Nature Chemistry*, 3(8), 571–571.

Tombolato, M. (2020). *La conoscenza della conoscenza scientifica. Problemi didattici*. Milan, Franco Angeli.

Vertesi, J. (2014). «Drawing as: Distinctions and Disambiguation in Digital Images of Mars», in C. Coopmans, J. Vertesi, M. E. Lynch, S. Woolgar (eds) *Representation in Scientific Practice Revisited*, MIT Press. pp. 15–35.

ISBN 978-88-944888-9-0

Proceedings of the 2nd International Conference of the Journal Scuola Democratica
REINVENTING EDUCATION
VOLUME III
Pandemic and Post-Pandemic Space and Time

Edited by: The Organizing Committee the 1st International Conference of the Journal Scuola Democratica. https://www.rivisteweb.it/issn/1129-731X
Published by: ASSOCIAZIONE "PER SCUOLA DEMOCRATICA" - Via F. Satolli, 30 – 00165 – Rome (IT)
FILE IN OPEN ACCESS

This book is digitally available at: https://www.scuolademocratica-conference.net/proceedings-2/