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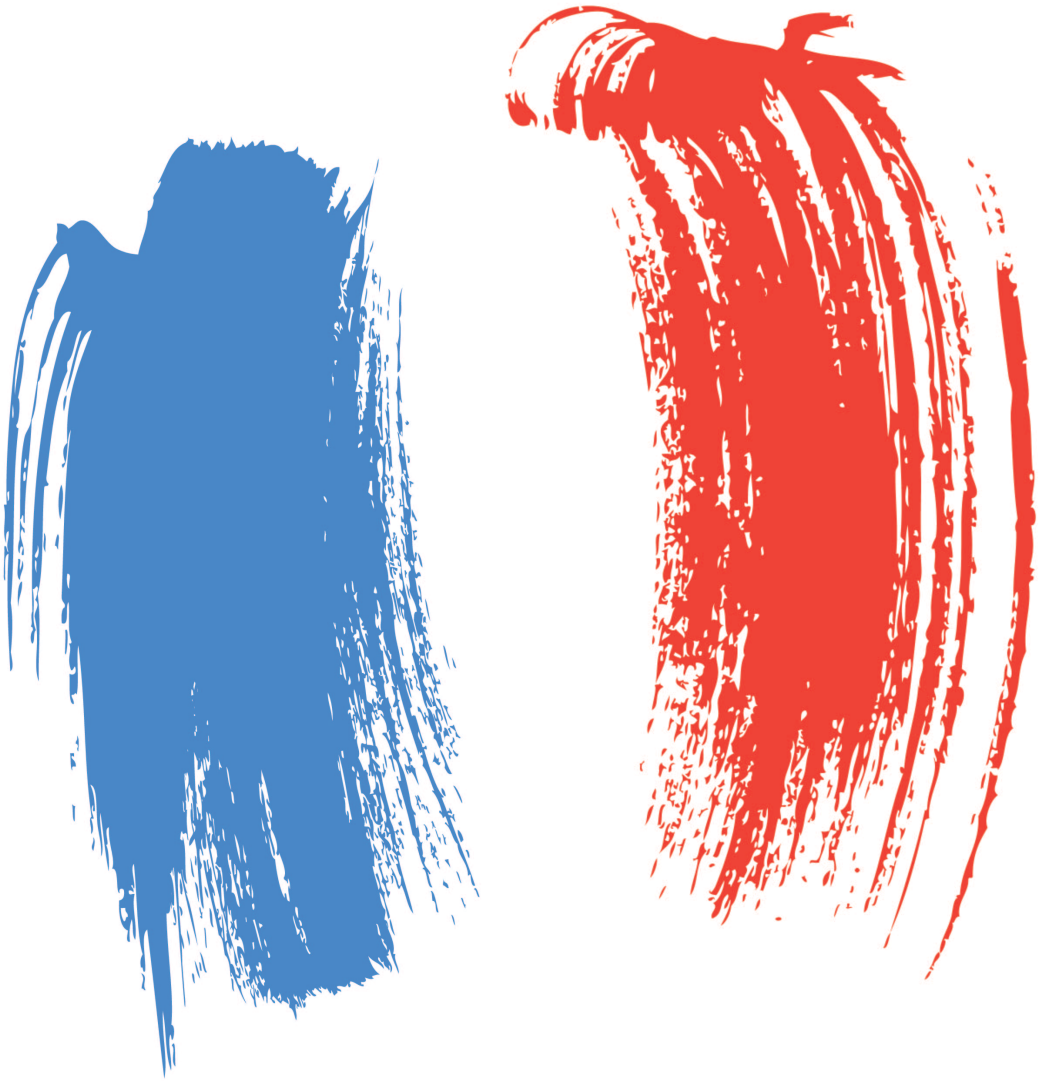

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Mapping, Coding, Learning: When Infographic Meets Digital Education –A Pilot Programme in Design School

Ida Cortoni, Sapienza University of Rome, Italy
Alessio Caccamo, Sapienza University of Rome, Italy
Carlotta Belluzzi Mus, Sapienza University of Rome, Italy

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Abstract
Media Literacy and Media Education are two concepts that are now endorsed and become part of the academic lexicon of contemporary society internationally and seem to be recognised for all intents and purposes as new processes of education within formal or informal educational contexts. This process, however, cannot be self-taught and entrusted exclusively to the experiential practice of everyone, but requires forms of cultural mediation in educational contexts, especially for the development and practice of more sophisticated transversal digital skills. In this sense, a growing number of researchers in different disciplinary fields claim the need for a 'design twist' in educational practices, with "Design" playing a leading role in terms of notions, processes, and no less distinctive intelligence. The discipline of Design, through the artefacts of Information Design - like infographics - can assist such pedagogical activities, facilitating storytelling in the acquisition of new content and tools supporting the educator in guiding the learning. Starting from these premises, the contribution - through the case study of the Digital Education programme of the master's in design, Multimedia and Visual Communication at Sapienza University - aims at critically reflecting on the relevance of disciplinary trespassing in the reconstruction of the methodologies of Design applied to future Digital Education. Contaminations useful for the research of new models, methods and processes that allow the design of new learning experiences aimed at the construction of democratic educational systems, inclusive and more adherent to contemporary challenges.

Keywords: Information Design, Digital Education, Coding, STEAM, Critical Thiking

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Introduction

In recent years, the international public and political attention has focused on the digital capital (Ragnedda et alii, 2019; Pitzalis et alii, 2016) of the school education system. By this expression, we mean the set of material resources (infrastructural technological endowment) and immaterial resources (digital skills) used in the performance of everyday activities in a circumscribed socio-cultural context such as school (Cortoni, 2020). The investment in digital capital in the school context, therefore, inevitably includes the strengthening of design skills and experimentation of appropriate teaching methodologies that, through technologies, can stimulate and enhance the child's learning, preserve the social and relational dimension with the educator, and stimulate an active participation and cooperation among students in the development of the activities. In this framework, optimizing the use of communicative technologies for an educational purpose also means investing in the implementation of t、he *human capital* (Coleman, 1988) of the teaching staff, especially in terms of *digital* skills and methodologies of the *digital education* approach,[1] to be experimented daily in the classroom with students and other educators.

In the two decades between the first Lisbon Strategy 2000 and the Europe 2020 Strategy, many initiatives have been promoted and supported aimed to have digital literacy included in the school system, with reference to the debate on digital competence.[2] Through the *Digital Education Action Plan,* in 2018 the European Commission proposes to improve the quality of pedagogical use of technologies in teaching and learning processes and foster the development of digital competences of teachers and students to cope with contemporary socio-cultural changes (Eurydice, 2019). The investment in digital capital is thus supported by the legal institutional awareness, shared at a European level, of including media education in the school curriculum and using technologies as a propaedeutic didactic support for *digital literacy* and for the stimulation of learning and implementation of students' competences. However, these policies are not always accompanied by teacher support and accompaniment strategies which help to concretely apply the digital education methodologies and procedures in the classroom and simultaneously safeguard the ethical, psychological, emotional, and physical integrity of children when using those same technologies.

In recent years, the use of STE(A)M (*Science, Technology, Engineering, Arts and Mathematics*) (Maeda, 2013, Perignan, Buonincontro, 2019), as a multidisciplinary and

[1] By this expression, we mean that teaching and learning process in which media, analogue and digital, are used as support for educational activities and as stimulation of digital competences (Hartai, 2014; Perez Tornero & Varis, 2010) and of the cognitive, metacognitive, and socio-emotional competences of citizens, young and old, in different educational contexts.

[2] In this regard, some of the European Commission's regulations concern: *Proposal for a Council Recommendation on key competences for Lifelong Learning* (2018); *Report on Literature Review of Reforms related to the 2006 European Framework of key competences for Lifelong Learning and the role of the Framework of these reforms* (2017); *Education and training 2020 Work Programme thematic Working Group "Assessment of key competences" Literature review, Glossary and examples* (2012); Recommendation of the European Parliament and of the council of 18 December 2006 on key competences for Lifelong Learning (2006); OECD Competency framework (2014); OECD, *the Definition and selection of key competencies* (2013); EU, *Digcomp: A framework for Developing and Understanding Digital Competences in Europe* (2013); EU, *Developing key competences at school in Europe. Challenges and opportunities for Policy*, Euridice Report (2012); EU, *A new skills agenda for Europe* (2016).

interdisciplinary didactic approach using *computational* thinking,[3] has been progressively legitimized in schools to promote the transformation of the traditional way of teaching scientific disciplines through a creative use of opportunities offered by ICT and digital languages, creating new experiential learning spaces for students. Based on the relevant scientific literature, the use of STEAM in a school context brings several benefits for the child's learning:

- *Cognitive***,** as STEAMs stimulate the capacity for independent and in-depth study, facilitating memorization and acquisition of disciplinary knowledge. In addition, STEAMs help implement certain soft skills such as the ability to identify connections between the acquired information, developing *high order thinking skills:* such as creative, analytical, reflective and metacognitive thinking, as well as problem solving skills.
- *Communicative***,** as STEAM allows the child to work using, in an integrated manner, multiple communicative languages (multiple formats and multimedia tools) and testing different ways of expression and representation of information. Children learn to argue their own choices, also using appropriate terminology.
- *Social-relational,* to the extent that STEAMs promote a methodological intervention that is predominantly collaborative and focused on teamwork. Students are stimulated to share their results with others, to discuss hypotheses and insights. The teacher thus gradually shifts from content provider to learning facilitator, while students are stimulated to experience a serene, democratic and inclusive atmosphere in their class.
- *Emotional-motivational,* as the STEAM approach enhances learning motivation towards the various study disciplines and curiosity.
- *Techno didactic* as STEAM stimulates different areas of digital skills: from creativity in the construction of digital artefacts to the communication and sharing of knowledge; from the ability to select and organize digital content to the skills of critical analysis of the same information including media.

The STEAMs, however, in this case do not represent the child's main learning objective but the methodological approach through which ~~to~~ design and test digital educational paths to enhance the child's learning and to implement knowledge also of humanistic disciplines such as geography, civics, history, mother tongue, etc. Starting in 2021, the *Digital Education Studio* research area in the Department of Planning, Design, Architecture Technology at Sapienza University of Rome has launched a *pilot programme* on the design and experimentation of communicative and digital artefacts for education in the *master's degree in Design, Multimedia and Visual Communication*.

1. Infographic as Visual Thinking Strategy

In recent years, due to the widespread use of digital media and its consumption, people must process a large amount of information in considerably less time than in the past, a time defined as perceptual (Riva, 2018). Physiologically, the intervals between information input and its perception are in the order of milliseconds. These delays, even though infinitesimal, can distort their interpretation because the brain - unable to process new information - will translate the input into inaccurate or approximate forms (Thwaites, 2000). Proper understanding of such artifacts requires competencies that go beyond mere factual and conceptual domains but extend to higher levels of learning - procedural and metacognitive domains - to stimulate critical

[3] Definition introduced by computer scientist Jeannette Wing in 2006: 'mental process underlying the formulation of problems and their solutions so that the solutions are represented in a form that can be implemented effectively by an information processor, be it human or artificial'.

thinking, which is essential for human development and the only defence against illusion, deception, superstition, and self-ignorance of ourselves and the world around us. Data visualization is not free from errors (Huff, 1954/2007), and when faced with communicative-infographic artifacts, the receiver tends to filter them through cognitive and social biases, influenced by their visual perception process. In general, there seems to be a bias of rejection towards the complexity of the communicative-infographic artifact, leading the user to see what they want to read (Cairo, 2020) due to the representation itself (Gibson & Gibson, 1955). Driven by the need to process information in minimal time (Riva, 2018), this attitude can generate a bias, causing the receiver to misread the information or not give it proper weight because it is deemed too complex and incomprehensible, leading to informational disorder.

As a communicative artifact, the infographic should not be considered merely a set of notions or interpretations but a process; and meanings are not exclusively internal to the works but are also produced through consumption (Falcinelli, 2014, p.101). To form a judgment of value resulting from perception, the receiver - when decoding a communicative-infographic artifact as a communicative process - applies patterns of interpretation, involving classification, organization, and connection (Gell-Mann, 1994). These patterns can be influenced by the level of attention - arbitrary and personal (Falcinelli, 2014) - that the recipient employs in consuming the artifact. Due to the richness of information contained in it, they might not be able to apply their critical thinking properly. Therefore, it is essential to focus on strategies that emphasize the logical-procedural structure in creating an infographic and activities based on the analysis of the artifacts themselves. If we taught "how something turns into something else, how styles change over epochs, how major artists have worked according to the message, means, and techniques of their time [...] then perhaps the public would be more ready to understand current transformations" (Munari, 1971/2017, p.107).

Munari's theory seems to be confirmed by several studies. For example, Yildirim et al. (2016) highlighted the effectiveness and preferences of communicative-infographic artifacts and their use in basic learning processes. Ibrahim and Alarmo (2021) showed that infographic teaching materials positively influence computer skills, e-learning, and motivation to achieve goals. Shaback (2017) revealed significantly higher results in the experimental group concerning educational infographic production in a controlled experiment. Nearly 90% of participants in the experimental group reported that infographics had a positive impact on their intellectual abilities, life skills, and emotional development. Alyahaia (2019), after assigning STEAM-related infographic design tasks, observed improvements in educational support in terms of effectiveness and communicative interest among students. Similarly, Bicen, Beheshti (2017) found that using infographics in education positively impacted academic success by improving knowledge retention in students. Kongwat & Sukavatee (2019) reported improved collaboration and team-building skills, message effectiveness, and understanding due to infographic use. Matix & Hodson (2014) highlighted how assigning research-based graphic design tasks in courses encouraged students' visual and digital literacy. Gareau, Keegan & Wan (2015) revealed a significant advantage in terms of accuracy for participants with any level of university education and a significant interaction between the type of stimulus (infographic vs. documents) and the condition (search vs. recall) with infographics leading to improved research performance. Lastly, Lastari & Silvana (2020) found that students believed the use of infographics motivated and allowed them to summarize assigned reading topics more easily. Positive effects were also seen in terms of active and collaborative participation in reading activities, allowing students to develop creativity and foster positive attitudes toward technology in educational contexts. It is not incorrect to state that before being an artifact, the infographic is a way of thinking, closely connected to visual thinking as theorized by Arnheim

(1969/1997). In the process of translating data into information, strategies of representation, analysis, synthesis, abstraction, and figuration are employed (Meirelles, 2013). The organization of informative content in an infographic - or Information Architecture - corresponds to a representation of information, as it is the first form of data visualization through the "transcription [...] of a thought [...] through the mediation of any system of signs" (Botta, 2006, p.31).

To develop a correct approach to competence, it is necessary to frame everything within a mental process of visual or, more precisely, infographic thinking. This is because visual languages are not isolated entities but widespread (Falcinelli, 2014), influencing the social, cultural, and cognitive planes. To stimulate critical Graphicacy skills, it is crucial to work on cognitive stimulation by reasoned exposure of the receiver to communicative-infographic artifacts, fostering a critical approach to these types of communicative artifacts and learning to read data critically. This approach revolves around the concept of the reflective practitioner by Schön (1983): a constructivist view of human perception and thought processes where the Designer constructs their knowledge based on experiences (Valkenburg & Dorst, 1998). According to Kokkos (2021), contact with art - in this case, communicative-infographic artifacts - can offer new and effective ways of giving meaning to the content itself through a critical reevaluation of our interpretation. Visual thinking strategies aim not only to form factual competence but also to facilitate the decoding of recurring patterns through "clarifying visual forms and organizing them into integrated patterns, as well as attributing such forms to objects" (Arnheim, 1969/1997, p.18). To do this, direct processing of complex information is reinforced to draw simple interpretations of the provided data (Borkin et al., 2013) through visual-based strategies. In this sense, infographics as artifacts and media serve as prostheses, meaning "artificial structures that replace, complete, or enhance a [...] performance" (Maldonado, 1997/2005, p. 141) of an informative nature. Infographics can also act as activators of critical thinking and reflection (Leggette, 2020; Liu, 2021), promoting improved critical skills when approaching visual information. Similarly, the creative production of infographics in different contexts (Jean, Kim, 2017) involves acts of naming, ordering, and parameterizing, which are interpretive acts representing a perspective on knowledge, reality, and experience (Drucker, 2014). Applying the theory of cognitive adaptation (Vessey, 1991), infographics and data visualization facilitate the identification of trends and relationships. While seeing is a natural act, perception is an enabling process (Dondis, 1973) intrinsically connected to thought (Arnheim, 1980). In the face of a communicative-infographic artifact, "we simultaneously look, read, and decipher, and we do much more, so much that we could find a verb for each action involving visualization [such as] analyzing, decomposing, relating, [and] comparing" (Falcinelli, 2014, p.154). According to Loukissas (2019), it is essential to consider new ways of thinking and critically seeing data and their visualizations, not just in terms of representation but also in the definition of a mental image of an idea, concept, or description. Moreover, the emergency lies in the fact that most processes related to Data Journalism are entirely hidden from the reader (Bradshaw, 2014). Finally, Data visualization techniques are not simply a means to make data more aesthetically appealing but rather "tensions of traction and pressure of content" (Falcinelli, 2014, p.219), providing a coherent form to discourses, making thinking visible, and enhancing analytical reasoning, data analysis, and cognitive development.

2. Edumat+, Pilot Programme of Design for Digital Education

The pilot programme, entitled Edumat+, is part of the experimentation on Digital Education and Digital Literacy, developed inside a *Digital Education Studio* in the Department of

Planning, Design, and Architectural Technology at Sapienza University of Rome. In this area oriented towards *Design for Digital Education*, for some years now the students of the master's degree have been training and designing communicative artefacts for education, which they experiment operationally inside the schools through their curricular internship. In this essay the focus will be on infographic mats for digital education designed for primary school children. This *pilot programme* represents an opportunity to share communicative and digital prototypes for education, to design, test and validate an innovative teaching methodology where the media artefact and coding can be integrated into the teaching setting and curricular programming as a methodology and communicative support for the achievement of curricular educational goals of not only scientific but also humanistic disciplines. The application of design to the area of *Digital Education* and STEAM as a support for teaching and learning in the humanities is still underdeveloped in the Italian context, there are few case studies of similar projects and few universities oriented to communication design with a specialization in *digital education* and *digital literacy*. The lack of studies and schools in this area is reflected in the public and political debate on digitalization, which, when it deals with digital capital, focuses mainly on strengthening the technological dimension of the media, neglecting the narrative, linguistic and interaction aspects that nowadays make media devices more than just devices, they are in fact true socio-communicative environments with significant socialization effects on children. Such media environments in fact require a design of the interface and the architecture of the media system of an educational type, attentive to the socio-emotional, psychological and cognitive traits of the reference target, in order to make precise expressive and structural choices of the communicative artefact capable of stimulating the internal and combined capabilities of the child (Nussbaum, 2002). [4] This is why it is appropriate to reflect about and explore communication design applied to digital education. Specifically, the *pilot programme* proposed by Sapienza in 2022 intends to support the use of communicative artefacts, both digital and non-digital, in school education according to Digital Education perspectives, through the design of infographic mats to be used, for educational purposes, in curricular activities in the primary schools. These mats focus the attention on the themes of the UN 2030 Agenda, the subject of in-depth study of the various disciplines of the Italian primary school, through an interdisciplinary approach and the involvement of curricular teachings, in compliance with the learning goals set for children attending primary school.

The project includes the use of STEAM educational methodologies oriented towards the implementation of coding activities with the help of a kit of physical robots (specifically Sphero Bolt), designed for the target age group of the project. The use of ~~the~~ robots is integrated with coding support services, so that any virtual applications for programming the robots can preferably and indifferently also be manipulated using smartphones, tablets, or personal computers.

Among the innovative aspects of the project, in addition to the use of STEAM as a teaching methodology for the development of pupils' disciplinary and soft skills, it is worth mentioning the use of visual language, through the infographic (not narratives) storytelling represented in the interactive mats, as a supporting factor for children's involvement and understanding. In the wake of Neurath's (1936) *Isotype*[5], the adoption of a visual language, with the aim of

[4] According to Sen (2000) and Nussbaum (2002), capabilities are what *people are actually capable of doing and being, having as a model the intuitive idea of a life that is worthy of the dignity of a human being.* they distinguish fundamental or basic capabilities for surviving in a social context, internal capabilities related to people's innate predispositions and combined capabilities, i.e. those capabilities stimulated by external socio-cultural stimulation that are transformed into competence

[5] *Isotype is* considered the first example of contemporary infographics.

'explaining by images', recalls the democratizing power of visual design, i.e., the possibility of transferring knowledge clearly to many subjects with heterogeneous skills. In fact, the iconic language (mainly infographics) is easily recognizable and interpretable even by those who do not possess adequate linguistic codes (e.g., immigrant students), by those who may have learning disorders (dyslexia, dyscalculia, etc.), as well as by students with different learning and expression times, starting from the different cultural stimulations of the socio-cultural family context.

The *Edumat+ pilot programme* consisted of three main macro-phases:

1. Design and prototype.
2. Experimentation.
3. Evaluation.

The first phase, explored in more details in the following paragraphs of this essay, mainly concerned the design of the educational programme, starting from the analysis of the school's educational needs (i.e. understanding the psycho-cognitive and emotional characteristics of the target audience, the educational goals for each age group, and the educational programme traditionally carried out in the classroom by teachers with regard to certain humanities-related subjects) to come up with the design of the communicative and digital methods and tools to work effectively in the classroom. Specifically, the use of storytelling and coding methodologies (involving the stimulation of computational thinking through computer programming) combines the peculiarities of pedagogical content design with visual semiotics (reading, writing, coding, and interpreting visual texts) and stimulates experiential learning. These methodologies were used to create infographic mats focused on the themes of the UN 2030 agenda, used in an integrated way with a robot kit capable of moving and interacting in physical and digital environments, such as infographic carpets.

The second phase of experimentation with the designed communicative artefacts involved the organization of a 20-hour digital education course lasting 5 months within the classroom where children, divided into working groups and supported by media educators, worked on the interactive mats using coding to explore different topics including water pollution, the shapes of matter, the seasons, and living and non-living beings. Each group focused on each mat for about a month (4 hours), changing topics and activities in the following months. Some of the didactic methodological principles at the basis of the activities proposed during the experiment concerned peer education and cooperative learning, the active participation and the emotional involvement through the use of multimedia languages and digital tools, the capabilities of comprehension, memorisation of information and expression and designing coding activities with the support of media educators.

Lastly, the experimentation promoted the evaluation of the training course *in itinere* through the use of two instruments: an evaluation form on the educational and relational environment built in the classroom among the children and with the educators, filled out by two research observers from outside the programme, and an evaluation form on the soft skills progressively acquired by the students while working with the map, filled out by the media educators involved in the experimentation at the end of each meeting (Cortoni, 2016).

3. Design and Pedagogy: The Value of Interdisciplinary Research

The research reflects the current trend of integration and dialogue between design disciplines and experimental pedagogy; indeed, Design Culture, if correctly included within the School's innovation processes, can respond to the functional needs of the new pedagogy, dynamically reinterpreting the transition from the traditional to the contemporary (Gislason, 2009; Stadler-Altman, 2018). While this focus is often exclusive to an interdisciplinary relationship between Pedagogy and Architecture, it is now more necessary than ever to open up such innovation to the discipline of Design. The school that wants to be futuristic and that intends to move from traditional to innovative solutions, must accommodate objects, tools and contents that have not necessarily been studied by the actors of the school itself, but belong to methodological and thinking approaches belonging to other contexts (Weyland, 2019). In this sense, what this project highlights is precisely the value of adopting a design-driven approach within the design of digital education services, an approach that suggests a change of perspective (Verganti, 2009) that can be easily evaluated and validated. It is possible to find a confirmation of this willingness to open up to interdisciplinarity precisely within the objectives and structure of the Edumat+ project. With respect to the path undertaken, as mentioned in the previous paragraphs, in fact, the entire methodological structure of the experimentation follows a Design Thinking model (Meinel & Leifer, 2012) that can be associated with the Double Diamond approach (Ball, 2019), as it is structured on distinct and consequential phases of research, conception, prototyping and experimentation, as described above. This method, already known in research belonging to other disciplines than design, allows designers to apply the knowledge acquired in a conscious and functional manner to the specific application phase in which one finds oneself, proceeding in an orderly manner towards obtaining a tangible result that is effective and at its maximum potential in terms of artefact-user interaction. Not only that, the Design Thinking framework allows the research and project team to integrate analytical skills with creative attitudes, facilitating participatory design as much as possible (Malena, 2023) Since this is a research project on STEM subjects, moreover, the pedagogical structure of the activities submitted to the children will also follow a model similar to Design Thinking, a methodological overlap that accentuates the need to rethink the School through a broader and more inclusive view of group research. From an application point of view, interdisciplinarity mainly involved two closely related phases:

a. *Knowledge Transfer*
   During the research and contextual understanding phases, it was necessary for project team members to update and expand their knowledge and skills in terms of Design for Communication, Infographics, and Instructional Design. In this sense, the acquisition of knowledge from the complementary disciplines allows designers, communicators, or educationalists to have a stereotomic view of the methodologies and theories applicable to the project, for an effective and valid result from a scientific and implementation point of view.

b. *Map artefact design*
   The construction of the design and storytelling for the map artefact was geared towards the assumption that this communicative artefact should play the role of a pedagogical tool. In this sense, the graphic design phase had to be flanked by a pedagogical storytelling and content project well defined in all its steps, first translated into a storyboard that translated the various moments of the story into images, then into a 2x2m infographic, which flanked the design with data, call to action and appendices

functional to the use of the digital tool as well as to the communication of the educational content.

Paradigms from primary level education, visual and multimedia communication design and data visualization thus contributed to the construction of a hybrid model of conscious design that facilitated complex learning actions not only of school notions, but also of Digital Education and Coding. Through confrontation, dialogue, exchange, and reciprocity, it was possible to motivate to a cooperative form of knowledge construction (Jonassen, 1994) that would enhance the discipline of Pedagogy with the expressive and intuitive character of Information Design, already, as mentioned above, loaded with pedagogical value. Similar experiences contribute to building a network of shared actions and knowledge open to the scientific community, which stimulates interest and growth for a Design-driven innovation of school systems oriented to the new needs and challenges for the future (see the teaching theme related to Digital Literacy). Furthermore, in conclusion, taking into consideration the methodological structure and action steps just described, it was possible to provide students and project stakeholders with the tools to start a constructive reflection on the role of Designers and the discipline of Design (Camuffo & Dalla Mura, 2017) in the future of learning processes.

Conclusions

Downstream of the experimentation, as well as during the development and prototyping phases of the maps, it was possible to validate how an interdisciplinary approach, which intersects skills and knowledge from both Pedagogy and Design, is necessary and sufficient to enhance the experimental pedagogical activities, especially when integrated with digital tools. It is no coincidence that the design and methodologies pertaining to Design Thinking have long since been borrowed by educators in the sphere of Instructional Design - precisely - and the proposition of new educational activities.

In this sense, research must set itself the objective of participating in this hybridization process through experimental actions and in-depth theoretical and methodological investigations, identifying touchpoints and potentialities of an increasingly integrated design between the two disciplines. Digital Education activities, if designed starting from a Design-oriented approach, or Design-driven in more extreme cases, can acquire better characteristics for children with respect to usability, memorability and intuitiveness, all indispensable variables in the construction of services, products or experiences addressed to a specific user identified upstream.

Edumat+, with its strong experimental character related to the use of storytelling for infographics, intends to be a case study in this sense for researchers in Design and Pedagogy who intend to investigate this field of scientific interaction. Therefore, the aim and hope is to pursue the development of the project, implementing the tested prototypes and reaching a level of development such that it can offer an integrated design model for educators who wish to make use of this interdisciplinary approach.

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References

Alyahya, D. M. (2019). Infographics as a Learning Tool in Higher Education: The Design Process and Perception of an Instructional Designer. *International Journal of Learning, Teaching and Educational Research*, *18*(1).

Arnheim, R. (1980). A plea for visual thinking. *Critical Inquiry*, 6(3), 489–497.

Arnheim, R. (1997). *Il pensiero visivo. La percezione visiva come attività conoscitiva*. Turin: Einaudi. (1a ed. 1969).

Ball, J. (2019). The Double Diamond: A universally accepted depiction of the design process. Design Council. https://www.designcouncil.org.uk/our-work/news-opinion/double-diamond-universally-accepted-depiction-design-process/

Bicen, H., & Beheshti, M. (2017). The psychological impact of infographics in education. *BRAIN. Broad Research in Artificial Intelligence and Neuroscience*, *8*(4), 99-108.

Borkin, M. A., Vo, A. A., Bylinskii, Z., Isola, P., Sunkavalli, S., Oliva, A., & Pfister, H. (2013). What makes a visualization memorable? *IEEE Transactions on Visualization and Computer Graphics*, 19, 2306-2315.

Botta, M. (2006). *Design dell'informazione: tassonomie per la progettazione di sistemi grafici auto-nomatici*. Valentina Trentini.

Bradshaw, P. (2014). Data journalism. In *Ethics for Digital Journalists*. London: Routledge.

Cairo, A. (2020). *Come i grafici mentono. Capire meglio le informazioni visiv*e. Milan: Cortina Raffaello.

Camuffo, G. & Dalla Mura, M. (2017). Design e apprendimento creativo: questioni ed esperien-ze. Milano: Guerini e Associati.

Coleman, J. S. (1988). Social Capital in the creation of human capital. *American Journal of sociology,* 94, 95-120.

Cortoni, I. (2016). *App digital education*. Milan: FrancoAngeli.

Cortoni, I. (2020). *Le competenze digitali nella scuola*. Rome: Carocci.

Dondis, D. A. (1973). *Primer of Visual Literacy* (Rev. ed.). Boston: The MIT Press.

Drucker, J. (2014). *Graphesis: Visual forms of knowledge production*. Cambridge: Harvard University Press.

Eurydice (2019). *Early childhood. Education and Care in Europe*. Eurydice Report. Brussels.

Falcinelli, R. (2014). *Critica portatile al visual design: da Gutenberg ai social network: [come informano, narrano e seducono i linguaggi che ci circondano]*. Turin: Einaudi.

Gareau, M., Keegan, R., & Wang, L. (2015, August). An Exploration of the Effectiveness of Infographics in Contrast to Text Documents for Visualizing Census Data: What Works?. In *International Conference on Human Interface and the Management of Information*, 161-171.

Gell-Mann, M. (1994). Complex Adaptive Systems. In *Complexity: Metaphors, Models, and Reality*. Santa Fe: Addison-Wesley.

Gibson, J. J., & Gibson, E. J. (1955). Perceptual learning: Differentiation or enrichment?. *Psychological review*, *62*(1), 32.

Gislason, N. (2009). Building Paradigms: Major transformations in School Architecture (1798-2009), The Alberta Journal of Educational Research, vol. 55 (2): 230-248.

Hartai, L. (2014). Report on formal media education in Europe. *European Media literacy Education Study (EMEDUS),* Lifelong Learning Programme. https://www.academia.edu/37033951/La_metodologia_del_design_thinking_per_una_Didattica_Digitale_interdisciplinare_per_argomenti

Huff, D. (2007). Mentire con le statistiche. Monti & Ambrosini. (1° ed. 1954).

Jonassen D.H. (1994). Thinking technology, toward a costructivistic design model. Educational technology, XXXIV.

Kongwat, A., & Sukavatee, P. (2019). The Effects of Collaborative Reading Instruction Using Infographics on Student's Reading Comprehension. *An Online Journal of Education*, *14*(2), OJED1402010-12.

Lastari, D. S., & Silvana, R. (2020). The effects of summarizing using infographics on EFL learners'reading comprehension. *Globish: An English-Indonesian Journal for English, Education, and Culture*, *9*(2), 128-143.

Leggette, H. R. (2020). Visualizing the analysis: Using infographics to strengthen critical thinking skills. *Communication Teacher*, *34*(4), 333-339.

Loukissas, Y. A. (2019). *All Data Are Local: Thinking Critically in a Data-Driven Society*. Boston: The MIT Press.

Maeda, J. (2013). STEM + Art = STEAM. *The STEAM Journal*. Vol. 1: Iss. 1, Article 34. doi: 10.5642/ steam.201301.34

Maldonado, T. (2005). *Reale e virtuale*. Milan: Feltrinelli.

Malena, R. (2023). La metodologia del design thinking per una Didattica Digitale interdisciplinare per argomenti. Academia.

Martix, S., & Hodson, J. (2014). Teaching with infographics: practising new digital competencies and visual literacies. *Journal of Pedagogic Development*, 3 (2), 17-27.

Meinel, C. & Leifer, L. (2012). "Design Thinking Research," Understanding Innovation. In H. Platt-ner, C. Meinel, L. Leifer (Cur.), Design Thinking Research, 127 (pp. 1-10). New York, NY: Springer.

Meirelles, I. (2013). *Design for Information: An Introduction to the Histories, Theories, and Best Practices Behind Effective Information Visualizations*. Londra: Rockport Publishers.

Munari, B. (2017). *Artista e Designer*. Bari: Laterza. (1° ed. 1971).

Neurath, O. (1936). *International picture language; the first rules of Isotype*. London: K. Paul, Trench, Trubner & co.

Nussbaum, M. (2002). *Giustizia Sociale e Dignità Umana*. Bologne: il Mulino.

Perez Tornero, J. M., Varis, T. (2010). *Media Literacy and New Humanism*. UNESCO. Moscow: Institute for Information Technologies in Education.

Perignat, E., Katz-Buonincontro, J. (2019). STEAM in practice and research: An integrative literature review. *Thinking Skills and Creativity,* 31, 31-43 doi: https://doi.org/10.1016/j.tsc.2018.10.002

Pitzalis, M. et alii (2016). *Innovare a scuola. Insegnanti, studenti e tecnologie digitali*. Bologne: Il Mulino.

Ragnedda, M., Ruiu, M. L., Addeo, F. (2019). Measuring Digital Capital: an empirical investigation. *New media and Society*, 5, 1-24.

Riva, G. (2018). *Fake news. Vivere e sopravvivere in un mondo post-verità*. Bologna: Il Mulino.

Schön, D. (1983). *The Reflective Practitioner*. London: Temple-Smith.

Sen, A.K. (2000). *Lo sviluppo è libertà*. Milan: Mondadori.

Stadler-Altmann, U. (2018). Ambienti di apprendimento formali: gli edifici scolastici e le aule in-fluenzano i processi di insegnamento e apprendimento? Contributo teorico, in: formazione & insegna-mento. European journal of research and education (2).

Stamatel, J., P. (2015). How data visualization can improve analytical thinking in cross-national crime research. *International Journal of Comparative and Applied Criminal Justice, 39(1), 31–46.*

Thwaites, H. (2000). Visual design in three dimensions. In Jacobson, R. E. (2000). *Information Design*. Amsterdam: Amsterdam University Press.

Valkenburg, R. & Dorst, K. (1998). The reflective practice of design teams. *Design studies*, *19*(3), 249-271.

Verganti, R. (2009). Design-Driven innovation. Cambiare le regole della competizione innovando radicalmente il significato dei prodotti e dei servizi. Segrate: Rizzoli.

Weyland, B., Stadler-Altman, U., Galletti, A & Prey, K. (2019). Scuole in movimento. Progettare in-sieme tra pedagogia, architettura e design. Franco Angeli.

Wing, M. J. (2006). Computational Thinking. *Communications of the ACM*. Vol. 49(3) ACM.

Yıldırım, S., Yıldırım, G., Çelik, E., & Kaban, A. (2016). A study on the development of an infographic designer questionnaire and designer opinions. In *SHS Web of Conferences* (Vol. 31). EDP Sciences.

The International Academic Forum (IAFOR)
Sakae 1-16-26-201
Naka Ward, Nagoya, Aichi
Japan 460-0008
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