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Digital media and socialization in primary school: a sociological analysis of the Edumat+ experience for environmental sustainability and social inclusion

Media digitali e socializzazione nella scuola primaria: un'analisi sociologica dell'esperienza Edumat+ per la sostenibilità ambientale e l'inclusione sociale

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Abstract. The paper initiates a theoretical, scientific and methodological reflection on the design and experimentation of communicative and digital artefacts, such as infographic mats, within formal educational contexts, like primary schools, to educate on environmental sustainability and social inclusion by working on the implementation of soft skills in children. Since 2022, the Digital Education Lab of the Department of Planning, Design and Technology of Architecture at Sapienza University of Rome has embarked on an interdisciplinary path of designing and experimenting with educational paths through STEAM, titled Edumat+. The objectives are two: 1. to reflect on the educational effectiveness of the communicative artefacts, proposed in terms of enhancing learning and teaching processes in children's situated contexts, with particular attention to the linguistic and narrative strategies adopted, in relation to educational objectives and the cognitive domain; 2. to reflect on a procedural methodological framework underlying the design of media and educational artefacts in formal educational contexts, to analyse the socialization processes related to the use of technology in classroom, with particular reference to coding. This contribution will present the experience of designing and experimenting with the Edumat+ case study, reflecting on the complexity of effective interdisciplinary educational media design attentive to stimulating socialization dynamics in the school.

Keywords: STEAM, communication design, socialization, digital education, social capital.

Riassunto. Il paper avvia una riflessione teorica, scientifica e metodologica sulla progettazione e sperimentazione di artefatti comunicativi e digitali, come i tappeti infografici, all'interno di contesti educativi formali, come la scuola primaria, per educare alla sostenibilità ambientale e all'inclusione sociale lavorando sull'implementazione delle soft skills nei bambini. Dal 2022, il Digital Education Lab del Dipartimento di Pianificazione, Design e Tecnologia dell'Architettura della Sapienza Università di Roma ha intrapreso un percorso interdisciplinare di progettazione e sperimentazione di percorsi educativi attraverso STEAM, denominato Edumat+. Gli obiettivi sono due: 1. riflettere sull'efficacia formativa degli artefatti comunicativi, proposti in termini di potenziamento dei processi di apprendimento e insegnamento nei contesti situati dei bambini, con particolare attenzione alle strategie linguistiche e narrative adottate, in relazione agli obiettivi educativi e al dominio cognitivo; 2. riflettere su un quadro metodologico procedurale sottostante la progettazione di artefatti mediatici ed educativi in contesti educativi formali, per analizzare i processi di socializzazione correlati all'uso della tecnologia in classe, con particolare riferimento al coding. In questo contributo verrà presentata l'esperienza di progettazione e sperimentazione del caso di studio Edumat+, riflettendo sulla complessità di una progettazione efficace di media educativi interdisciplinari attenti a stimolare dinamiche di socializzazione nella scuola.

.Parole chiave: STEAM, progettazione della comunicazione, socializzazione, educazione digitale, capitale sociale.

THE IMPACT OF THE COVID-19 PANDEMIC ON EDUCATIONAL MEDIA RESEARCH AND EXPERIMENTATION

The COVID-19 pandemic represented a historic turning point in the field of educational media research and experimentation. The push towards equipping schools with technological infrastructure, driven by lockdowns, and the subsequent encouragement for digital training of educators from the post-pandemic period onwards, introduced new challenges in teaching methodologies. These challenges involved strategies for integrating and including media tools within educational settings, as well as the management and organisation of activities within new environments that are neither fully analogue and traditional nor entirely virtual. Enhancing the effectiveness of these new learning environments, now framed within the phygital perspective (Bazzanella et al., 2014) or onlife (Floridi, 2015)[1], has become the primary challenge not only for scientific research and academic teaching experimentation, but also for medium-to-long-term objectives of political and governmental bodies at both European and national levels.

Legislative indicators of this need for improving digital responses in education, following the 2015 Piano Nazionale Scuola Digitale (PNSD), have primarily been European funds aimed at increasing research and training in the digital field (Digital Europe, 2021–2027), as well as the National Recovery and Resilience Plan (PNRR), under the digitalisation and innovation section, as per Regulation (EU) No. 2021/241 of 12 February 2021 and approved by the European Council's Implementing Decision of 13 July 2021.

As part of the "Next Generation EU" European funds, in recent years, the Italian Ministry of Education has promoted the "School 4.0: Innovative Schools, Wiring, New Classrooms and Laboratories" investment line, focusing on enhancing the educational services within the Mission 4 – Education and Research. This initiative aims to create hybrid learning environments capable of combining the educational impact of physical space with the inclusive potential of digital environments. The Action Line 1 – Next Generation Classrooms, for both primary and secondary levels, has primarily focused on transforming and innovating classrooms, not only by creating new physical and digital learning spaces through furniture and equipment, but also, and most importantly, by integrating teaching methods and techniques aligned with the transformation of learning environments, ensuring the development of cognitive, social and emotional skills in students. The action targeted primarily local authorities and designers, providing them with resources to design school environments by involving all stakeholders with the goal of positively influencing teaching and learning for both teachers and students (Tosi, 2022).

This essay focuses on the design of innovative learning environments, as well as on teaching methodologies and educational media techniques, which adhere to the main characteristics of *new generation learning spaces*, namely: 1. Flexibility, understood as the ability to integrate innovative proposals with established teaching strategies; 2. Adaptability, meaning the continuous reconfiguration of the teaching setting to the relevant socio-cultural and educational context; 3. Stimulation, to orient towards solution-finding; and 4. Creativity, to inspire students (Tosi, 2022).

EDUMAT+: THE EDUCATIONAL MEDIA EXPERIMENTATION PROTOCOL FOR STEAM

Edumat+ is the design and educational media experimentation protocol promoted by the Department

[1] The use of neologisms, such as phygital and onlife, indicate how the hybridisation of the real and the virtual is creating a new concept of spatiality that is increasingly taking on the characteristics of a new 'place' of social as well as educational relations that has its own rules and modes of socialisation and interaction, hence, autonomous communication (Castells, 2014: 430-431).

of Planning, Design and Technology of Architecture at Sapienza University of Rome in 2022. It combines various methodological educational approaches within an educational pathway from different disciplinary fields: the sociology of communication and education, with reference to the theoretical and methodological reflections of media education, and the design of visual and multimedia communication, with reference to Information Design. This protocol originates and develops within the Digital Education Laboratory in the Master's Degree in Design, Visual and Multimedia Communication, and it fits into an interdisciplinary research and study line in the field of Digital Literacy and Digital Education. It questions the need for a critical design of communicative artifacts intended for an educational context, where linguistic, technological and aesthetic-narrative choices of the product take into account, first of all, the educational objectives of the intervention context, the educational needs (cognitive, emotional and social) of the target audience and, finally, the socio-educational methodology of integrating the artifact within the socio-cultural and educational context where it will be used.

Specifically, the protocol aims to design and test a teaching method that, respecting the structural archetypes of human learning, is applicable in the fluidity of digital learning spaces, yet with the solidity of a human-centred educational approach. Edumat+ thus proposes educational pathways predominantly on the themes of environmental sustainability and social inclusion, in line with the goals of the 2030 Agenda, for primary school children, within a digital education project that involves the combination of three innovative teaching methodologies using educational robots, tablets and infographic mats. These methodologies include:

1. **STEAM (Science, Technology, Engineering, Arts, Mathematics)** as a methodological and instrumental support to converge educational action in a hybrid learning environment that considers both theory and practice. This approach values the student within the learning ecosystem (Rivoltella, 2021) while favouring the use of active and simulation-based mediators (Rossi & Pentucci, 2021; Garavaglia & Petti, 2022), cognitively ergonomically designed to adapt processes, content and learning times, allowing learners to create and share their work, interact and collaborate with teachers and peers progressively and in ways that suit the specific learning needs of each (Barana et al., 2019; Romano et al., 2023).
2. **Coding**, using educational robotics, not only as a learning objective but as a strategy to stimulate computational thinking in terms of problem-solving and problem-setting. This methodology, attributable to Papert (1980) and Wing (2006), allows not only thinking in terms of sequences and rules thanks to the principles of visual block programming, but it also promotes values of cooperation and sharing, recognising the importance of exchanging mutual knowledge and overcoming mistakes and obstacles as forms of stimulating learning from a social perspective.
3. **Visual storytelling** forms the basis for the design and prototyping of infographic mats, as an educational methodology that integrates multiple factors: a. *Visual language* as a catalyst for the student's perceptual attention, a strategy for emotional engagement and a tool for facilitating understanding through symbolic play constructed from the choice and organisation of graphic signs within the narrative (Wujec, 2009; Walter & Gioglio, 2014); b. The power of narrative to build narrative thinking (Bruner, 1956), that is the mechanism of logical sense attribution to lived experiences by reconstructing organised knowledge, as well as hermeneutic interpretive processes related to significant concepts, c. The multimedia dimension, through the hybridisation of languages and devices, which increases students' immersion in knowledge and multi-sensory engagement, fundamental for emotional stimulation in children. From this perspective, the following gains importance: 1. The tactile dimension through the use of tablets and educational robots, which stimulate object manipulation as a learning enhancer; 2. The expressive dimension of visual communication design, present in the infographic mats, paying attention not only to the compositional elements of visual storytelling, but also to the principles underlying the graphic design of the mats (e.g., balance, hierarchy, repetition, emphasis, contrast, harmony, etc.), as well as the design and evaluation criteria for the arrangement of elements within the project (TeamWillBee, 2022) and *Universal Design for Learning* (UDL) (Rose et al., 2006); 3. The interactive dimension related to multimedia design, constructed through QR codes and augmented reality devices, applied to mats and interacting with the educational robot, which, respecting Mayer's principles (2003), enhances multimedia learning.

The application of these methodologies within the Edumat+ protocol inevitably refers to some cross-cutting pedagogical educational principles, which underlie any educational methodological intervention, such as constructivism (Kelly, 1955) centred on the active construction of knowledge through the student's active involvement and the emphasis on experiential learning (Dewey, 1949; Merriam & Bierema, 2013), the use of symbols and languages as socio-cultural mediators to facilitate learning (Vygotskij, 1978; Lave & Wenger, 1991; Merriam & Bierema, 2013), not to mention the stimulation of self-directed learning (Zimmerman 1989), thanks to a situated experience (Stahl et al., 2006), that includes not only socio-cultural factors but also the mediation of tools such as books, maps and technological devices (Engeström 2016; Merriam & Bierema 2013; Nardi 1996). Activity Theory (Leont'ev, 1978) is then a valuable theoretical support for understanding the constructivist dynamics to be applied with STEAM; it considers simultaneously the subject participating in the activity, the "object" (auxiliary tools or signs) that motivates the activity, tangible or intangible, and the community (Engeström, 1987, 2016), investigating the interactions between different activity systems, participation and the quality of collaboration and analysing the processes of redefining the objectives of individual systems, even if only partially shared (Engeström & Sannino 2010). The STEAM approach indeed aims to design and build the learning context socially, to the extent that teachers and students are actively involved in the educational situation, learning reciprocally.

OBJECTIVES AND INTERVENTION METHODOLOGY

The expected learning objectives for this intervention strategy were numerous and were therefore consolidated into two macro-categories: 1. objectives related to the students' human capital, which include enhancing cognitive and metacognitive skills, disciplinary and soft skills, including those related to digital technology and coding; 2. objectives related to the students' social and relational capital, attributable to the teaching methodology adopted, which is attentive to the students' social well-being when interacting with technological devices in educational contexts such as schools.

From the perspective of human capital (Coleman, 1990), understood as the cognitive and metacognitive enhancement of students' soft skills, computational thinking (Papert, 1980) can certainly be included. This is implicit in the use of STEAM through coding and is generally structured around four main pillars:

1. Decomposition of a problem into smaller, manageable parts, which facilitates the development of diagnostic, observational and analytical skills related to the context and process, preliminary to designing any problem-solving proposal (keywords: decomposition, analysis).
2. Recognition of patterns already present, which implies the development of critical thinking skills, such as evaluating reality, applying prior knowledge to new social situations and reflective capacity, fundamental for making predictions and formulating solutions in situated contexts (keywords: evaluation, application, reflection).
3. Abstraction, understood as extrapolation of general and essential information to design simple models, eliminating all redundant information (keywords: abstraction, reflection, generalisation).
4. Algorithmic design, understood as constructing and applying logical sequences to solve concrete problems (keywords: designing, programming, algorithm).

In addition to computational thinking, the development of further soft communication skills related to enhancing students' expressive and communicative abilities through the independent use of different codes, as well as the use of appropriate terminology in an interdisciplinary perspective throughout various activities, can be added.

In the context of the project, coding activities were connected to the remote use (via tablets and web applications) of an educational robot, Sphero Bolt, on infographic mats (3 metres by 3 metres), designed by the researchers at the Digital Education Laboratory of Sapienza University. These mats, through visual storytelling, graphically represent themes related to the humanities subjects in various primary school classes, as outlined by the National Guidelines for the school curriculum of 2012. This use was partly guided by educators and partly designed for students to execute autonomously in problem-solving tasks.

In this sense, the coding activity was integrated into an educational media project where the digital device also served as a cognitive and emotional stimulator to support the interactive and dynamic transmission of other disciplinary knowledge to students, within an ecological perspective where technology interacts with other analogue tools for more general educational objectives. Specifically, the integrated use of the robot through coding activities on infographic mats aimed to achieve further cognitive objectives in children, such as facilitating memory processes, deepening knowledge of the topics introduced in educational pathways, conceptual linkage between different pieces of information, stimulating creative skills and problem-solving, as well as reflecting on the story told and the proposed activities, including those involving the robot.

From the perspective of social and relational capital (Bourdieu, 1977), in order to maintain peer relationships and interactions with educators during the use of technological devices, the protocol involved adopting classroom intervention methodologies that considered group work, the identification of roles within work groups, as well as discussion and cooperative learning for carrying out exercises and planned activities, promoting non-competitive but collaborative relational modes among peers, even concerning device use.

EDUMAT+: PHASES OF THE PROTOCOL

The design of the protocol involved four main phases:

1. Preliminary investigation of the sociocultural context of the primary school and the Italian education regulations, to align the educational media project with the school's current characteristics in terms of expected educational objectives and presumed disciplinary and interdisciplinary teaching load per class level. This was supplemented by an analysis of relevant literature regarding cognitive stimulation types and levels expected by age group, essential for defining the average complexity of the proposal, considering the presumed variability of intervention linked to the specific characteristics of the class.
2. The design of the educational pathway, which included three main actions and three corresponding outputs: a. *Mapping*, or the development of visual storytelling within infographic mats starting from constructing narratives on environmental sustainability topics, primarily related to science and civic education subjects in primary school curricula; b. *Coding*, or the design of coding activities to be proposed to children on the infographic mat using educational robots, such as Sphero Bolt; c. *Planning*. The logistical design of the protocol included a structured pathway for each mat consisting of four 50-minute sessions, corresponding to four narrative moments of visual storytelling per mat, totalling four sessions to be completed over approximately a month of experimentation. The main outputs associated with this action were:
   - The planning booklet, providing pedagogical, methodological and procedural guidelines for teachers/educators to effectively use each mat in class.
   - The infographic and interactive mat related to mapping, to be printed; through visual storytelling, each mat graphically represented activity pathways for children on environmental sustainability topics.
   - The coding of the narrative and activities to be applied on the mats using Sphero Bolt. The design of coding activities also considered the presumed learning development of children by age and the hypothetical cognitive domain, to calibrate the difficulty level of the proposed activities.

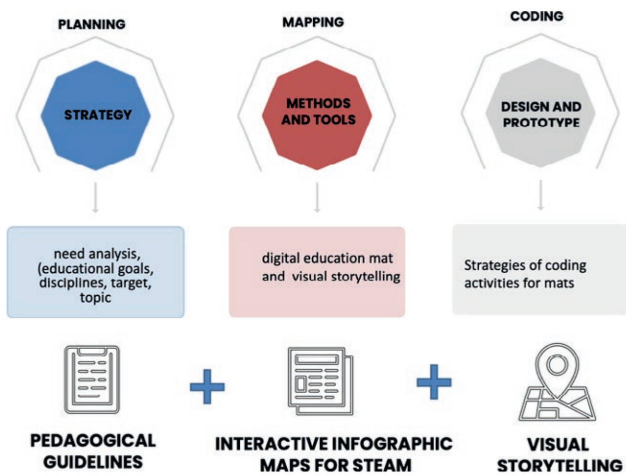

Figure 1. The actions of the Edumat+ educational media pathway design.

3. Experimentation of the mat within primary school classes to verify its educational effectiveness, concerning student learning, and improve the training proposal in relation to the concrete cognitive and social needs expressed by the students during its use.
   In the experimentation, the individual sessions of the training programme were designed and managed with the "Deming Cycle – PDCA" methodology (Sancassani et al., 2019). This methodology involves structuring all sessions into four main stages:
   a. **PLAN.** Introduction to key concepts and the lesson's storytelling related to the topic of the infographic mat.
   b. **DO.** Practical workshop activities, related both to coding and other analogue and traditional artefacts, to be carried out independently or with the support of the educator during the lesson.
   c. **CHECK.** Continuous monitoring to ensure that objectives are met and that all students have acquired the new skills outlined in the lesson's objectives. Through constant monitoring of students' behaviour during the proposed activities, the media educator consistently verified that all lesson objectives were achieved and that students had grasped the key concepts shared during the lesson.
   d. **ACT.** At the end of each session and the project, the teacher always evaluated the work with the students, observed and identified issues and potential

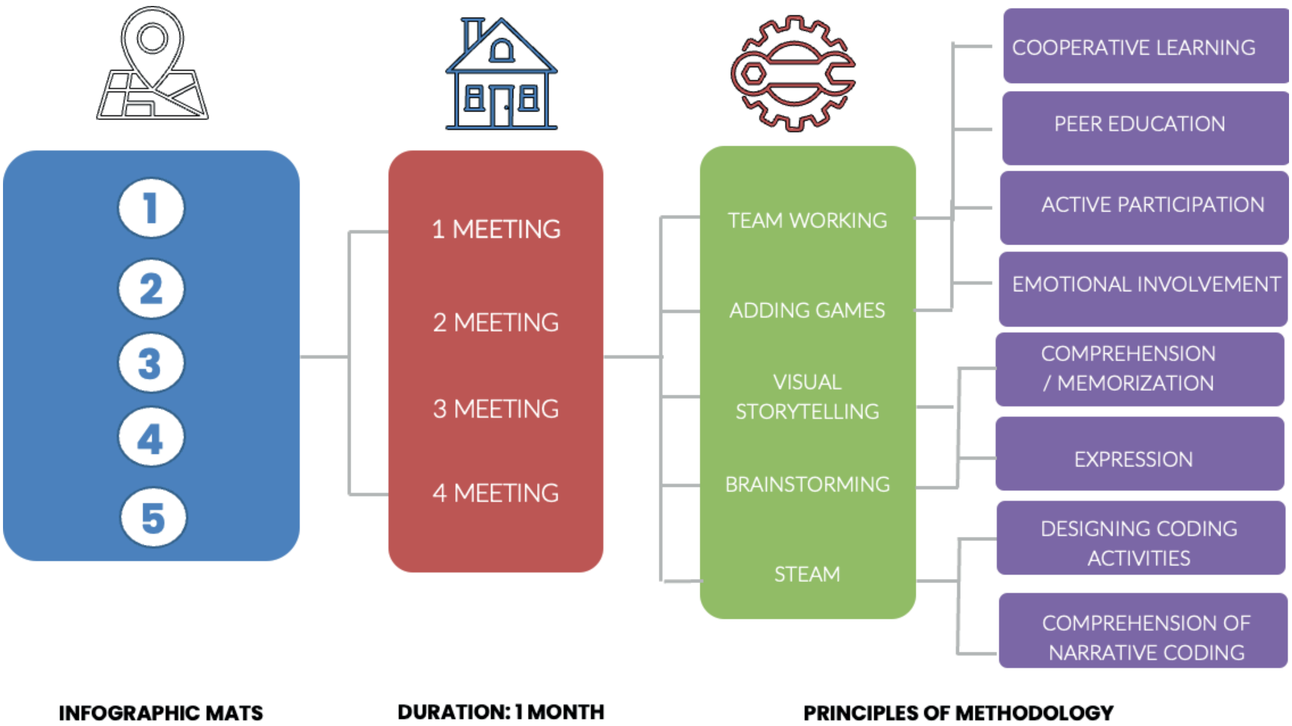

Figure 2. Summary of Edumat+ experimentation.

causes, to implement corrective actions for future use. Specifically, at the end of each meeting within the workgroup, the media educators conducted a reflective brainstorming session (Bezzi & Balbini, 2006) with the students regarding what was learned during the activities.

4. Evaluation of the proposed activities in the experiment, using two assessment tools completed by media educators: the first related to the ongoing assessment of each student's human capital at the end of each session and the second related to the analysis and evaluation of social capital during the experimentation. In the first case, the focus was on observing children's behaviour in relation to the proposed media educational stimuli, related to the learning objectives of the project; specifically, an assessment rubric (Davidson, 2005) was constructed using descriptors from the five experience areas outlined in the National Guidelines for the 2012 curriculum on a structured 3-point scale. The choice to value these experience areas, traditionally used as learning goals in early childhood education, in primary school derives from their semantic connection to the development of soft skills in children, which include a. The construction of self through the progressive development of autonomous and confident behaviour in carrying out proposed activities, also respecting the environment and others during these activities (self and others); b. The ability to recognise, understand, analyse and evaluate expressive graphic signs through images, sounds and colours, initiating a process of coordinated image education (images, sounds, and colours), c. The expressive ability to communicate and share knowledge, information and emotions within the group with peers and educators using appropriate terminology (speech and words); d. Knowledge of the disciplinary topics addressed in the educational sessions of the pathway, the topics and languages of coding, as well as knowledge and respect for the surrounding space and its objects (knowledge of the world).

In the second case, the focus was on relational dynamics and the classroom climate established during the project's activities. Through an observation sheet of the social space and relational dynamics, the media educator observed and evaluated for each session the learning environment (group climate, teaching setting, space organisation, and environment during experimentation, group characteristics, the media educator's relationship, and the presence of hyperactive or inactive children in relation to the presented proposal); the media educator's educational intervention and the children's behaviour in response to the proposed inputs, the teachers' attitudes during experimentation, the communicative effectiveness of the infographic mat, as well as the children's reactions to the educational robot and coding.

At the end of the entire educational pathway, through a brainstorming activity with all children involved in the experiment, students shared with their peers and educators what they had learned at the end of the project, both in terms of coding and the themes explored in the visual storytelling of the infographic mats.

THE TEACHING METHODOLOGY OF EDUMAT+

Within the general framework of the Edumat+ structure, particular attention must be paid to the methodological reflections that characterised the experimental phase of the project. All digital education activities proposed within the protocol aimed primarily at preserving the child's well-being while using digital devices, focusing on three fundamental dimensions: the body, the mind, and relationships.

The "body" is a metaphor for the development of the child's individual and social identity within physical space. The educator's role, in the presence of the device, was to ensure digital use did not compromise the development of the child's "body" dimension, crucial for their physical well-being during primary socialisation. During the experimentation, device use was integrated with the physical mat on which the children moved, observed and carried out exercises, as well as brainstorming activities to search for objects and solve problems among peers based on inputs provided by the educator. In this regard, coding activities proposed using educational robots and tablets alternated with manual activities in a confined space, ensuring awareness of one's body in real space even when using digital technologies.

The "mind" refers to the psychological, cognitive and emotional well-being that needs to be preserved in the child when using technological devices. The stimulation associated with device use was never an isolated factor but always interacted with the socio-educational context of its use. Thus, the pedagogical intervention on the methodologies for applying technologies becomes central to enhancing opportunities for media use learning and reducing isolated, passive and non-participatory forms for children. Within the protocol, all media stimulations proposed in the educational path were carefully selected by the educator, based on preliminary educational and didactic objectives and the expected learning outcomes for the student. The media stimulation proposed to the children was integrated into a system of material and virtual stimuli, all aimed at achieving the same educational and learning objectives, with the child actively involved in progressively autonomous understanding of their experiences, while the educator acted as a mediator and facilitator of the stimuli provided by the various educational supports.

Finally, the "relationship" refers to the child's social well-being and highlights the interaction and relational dynamics that underpin the social and cultural capital of children, which needs to be preserved with technology. From a digital education perspective, it was crucial to ensure self-regulated and integrated device use, which valued exchange, sharing, peer and educator interaction, communication and collaboration in the child's daily activities with the device (Bailey & Shaw, 2020; Burnett et al., 2022). During the experimentation, the proposed activities were always collaborative and organised in small groups to promote cooperative learning (Anderson, 2006) in performing tasks and solving problems, including those related to coding. Pro-social activities also help overcome or mitigate negative emotions such as fear, sadness and aggression, fostering solidarity and mutual support in times of difficulty. Therefore, even when using digital devices in an educational context, it is important to preserve mutual support in difficulties, promoting collegial media consumption within small workgroups with the mediation of media educators to ensure active involvement and participation of the entire class.

MAIN OUTPUTS OF THE PROTOCOL

Within the Digital Education Lab at Sapienza, under the Edumat+ protocol, 16 media educational pathways for primary schools were designed, as outlined in the Table 1.

For each pathway, an educational kit was structured, consisting of three products: 1. a booklet for educators, 2. an infographic mat to print, 3 a coding programme to use on the mat for each session with the educational robot Sphero Bolt.

The experimental phase of the Edumat+ protocol, which will continue over the next school years, in 2023 involved Class I A of Goffredo Mameli primary school in Palestrina (RM), using mats designed for first and second-grade classes for 4 months. In 2024, it involved Class II A for the use of mats designed for second and third-grade primary school classes. Each year, before starting the media educational pathway, a coding literacy module

Table 1.

Classroom of primary school	TITLES OF MATS			
	1	2	3	4
I (6 y)	La magia delle 4 stagioni	Lindalandia. Che cosa è l'inquinamento	AcquaAmica una risorsa preziosa	
II (7 y)	Che cosa è la materia. L'indimenticabile gita di Alice	Sinfonia visiva	Chip e la foresta addormentata. Gli esseri viventi e non viventi	
III (8 y)	Bioma terrestre: L'ecosistema: il regno animale e vegetale	Plastibot e smorg! Gestione dei rifiuti	Il viaggio di Brico e Crisalide. Tutela della biodiversità	
IV (9 y)	Alla scoperta di Gea, marino, Alisea: il suolo, il mare, l'aria	Mr. Futuramb. La raccolta differenziata	Esplorando il territorio	
V (10 y)	Alimentazione sostenibile	Clima, in viaggio fra terra e spazio	Energie rinnovabili, un'avventura spaziale	Lo stivale minacciato e le quattro sorelle. Il dissesto idrologico

(approximately 4 hours spread over several weekly sessions) was proposed to the children to teach them to use the educational robot through remote control via tablet and to familiarise them with the programming language and procedures, that would be referenced during the actual experimentation with the infographic mats.

In both cases, the educational approach was consistently the same, involving the division of the class into small groups of 4/5 children supervised by two media educators. The composition of the groups was entrusted to the class teachers, who, being more familiar with each child's emotional and psychological characteristics, were able to balance the workgroups. Each group had an infographic mat, one or more Sphero Bolts, and the corresponding tablets to programme them.

Once a week, each group was taken to a classroom, or other available school space, for the experimentation, where they worked with media educators on a topic represented by an infographic mat for about a month (a total of 4 sessions of 50 minutes each, held weekly). The following month, each workgroup changed topics, the infographic mat and media educators with whom they interacted. The class teachers were always present during the experimentation, supporting the management of children in small groups and intervening in cases of disorder or noise. At the end of the experimentation period, all students, albeit with varying timescales, had the opportunity to explore at least 3 topics related to environmental sustainability, consistent with the educational objectives of the class and some subjects included in the curriculum across various disciplines (primarily civic education and science, but also Italian language, Music and occasionally English language), learning some principles of coding applied to the use of educational robots.

REFLECTIONS FOLLOWING THE EVALUATION OF THE EXPERIMENTATION

From a social capital perspective, the classroom climate during the experimentation was predominantly friendly and collaborative. Children participated enthusiastically in the project due to its innovative activities, which stimulated the curiosity of both students and teachers. However, there were moments of confusion within the small groups, caused by various factors such as student fatigue, especially in the final months of the project, the presence of students with learning disabilities not always supported by designated figures and the often overly friendly relationship between educator and student, which led the latter, especially towards the end of the project, to neglect some principles and conduct rules essential for harmonious activity execution in the lab.

Regarding the availability of spaces, the school did not always have classrooms available during curricular hours for conducting cross-disciplinary activities as those provided by Edumat+. Nevertheless, teachers and administrative staff continuously collaborated to identify suitable spaces for each scheduled session in the experimentation.

The class involved in the experimentation was very eager and lively, though sometimes distracted due to fatigue and disinterest, especially in situations requiring repetitive activities. For this reason, media educators frequently had to enrich the activity set, sometimes increasing the complexity and difficulty, following the principle of personalised teaching within small groups. During sessions, media educators employed both "proximal approaches", utilising visual representations of the infographic mat and various connected educational sup-

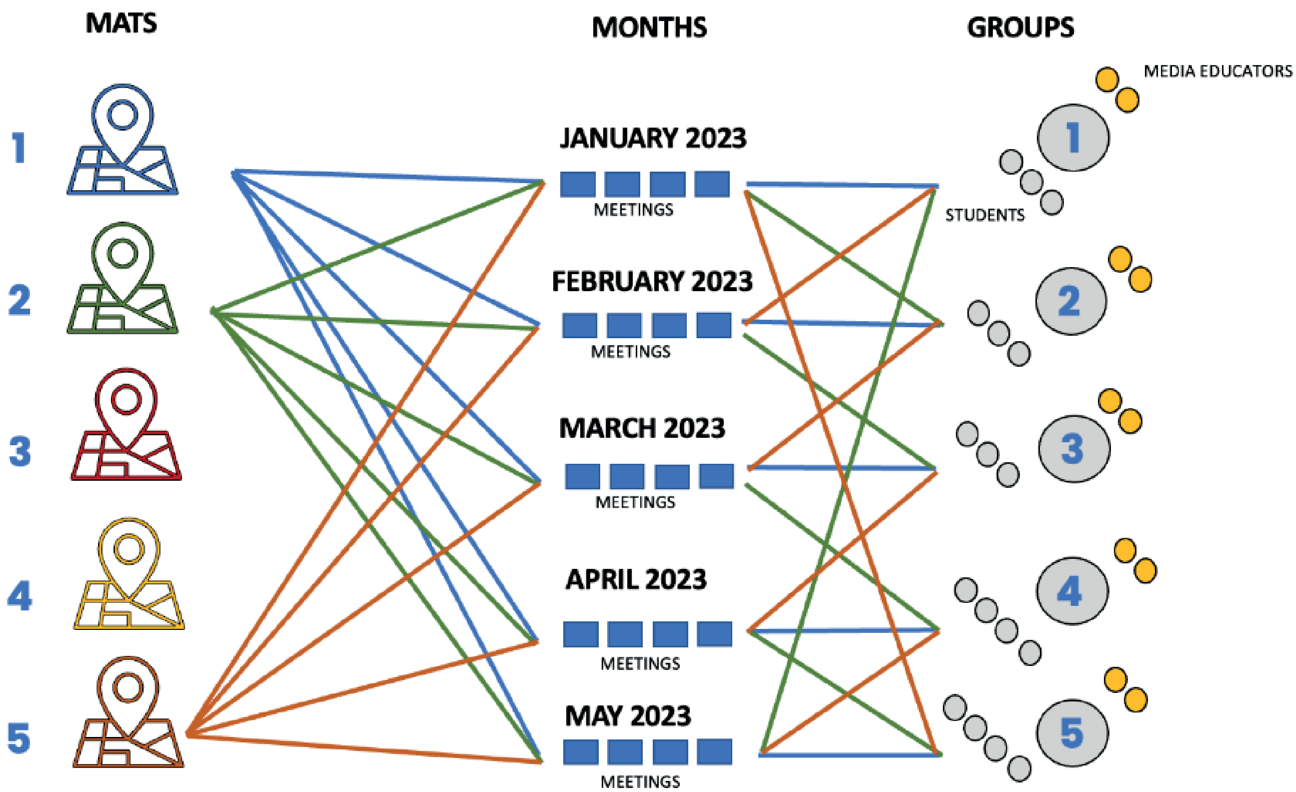

Figure 3. Example of applied experimentation in Edumat+ in the Goffredo Mameli school of Palestrina.

ports to enhance interest, engagement and participation, and "distal approaches" through the use of technological devices (robots and tablets) as well as other material objects (modelling clay, puzzles, dice, etc.). The experience revealed that a media educational pathway involving active and participatory use of technologies by students should be managed within small workgroups (max 4/5 children) to ensure continuous engagement during activities. In this regard, preliminary training for teachers in coding literacy through robots and a process of supporting the application of the protocol in class would be beneficial, reducing the role of external media educators and promoting progressive integration of media educational activities with STEAM in the school curriculum without external experts.

From a human capital perspective, the use of tablets during laboratory activities to manage coding with the robot significantly contributed to develop students' autonomy, self-esteem, self-confidence, and self-reflection regarding their work. Moments of competition for managing the tablet did not arise within the groups; students always respected turn-taking and often worked together to find solutions for building paths with the robot.

Sphero Bolt quickly became a focal point of attraction and innovation in the class. The instinct to handle it was strong, especially in the initial sessions. However, the introduction of the robot was immediately accompanied by usage rules, central to conduct activities while ensuring the safety of the children and technological supports. These rules were frequently shared with the children during the experimentation. While programming Sphero Bolt, the media educator, after providing essential instructions, always allowed all children in the group the opportunity to work independently and the freedom to make mistakes and learn from them through self-correction and self-assessment.

The infographic mats were the second innovative media educational element of the protocol. The graphic design, which includes the background drawing underlying the storytelling, the complexity of the graphical depiction of characters and story objects, and the choice of colour palette, was not only the result of aesthetic choices, but was always based on scientific and reasoned decisions, in line with guiding principles related to communication design primarily aimed at children.

Following the initial meetings with students during the coding literacy phase, media educators, graphic designers, decided to modify the original designs of the mats, simplifying the representations in some cases, removing redundant and distracting objects and reducing the complexity of some activities to better align with the cognitive and psychological characteristics of the class group encountered. At the end of the experimentation, it can be stated that the communicative artifacts captured students' attention and stimulated their curiosity; the graphic representations were intuitive and easily understood by the students, allowing them to memorise concepts and information shared through the proposed storytelling.

CONCLUSION

The case study presented in this article can be considered innovative for several reasons: firstly, it is the result of an interdisciplinary scientific and design reflection process involving various disciplines, such as cultural and communication sociology, educational sociology, and visual and multimedia communication design. It was also innovative in its attempt to combine principles and methods of media education with the STEAM approach, particularly as a working method for teaching even humanistic subjects, visual storytelling and information design for the design of communicative artifacts of the mats, aiming to emphasise the learning stimuli resulting from the coordinated application of these methodologies within a single process. The project not only involved designing and prototyping infographic mats but also reflecting on their concrete use and application in class, respecting some fundamental pedagogical principles to ensure engagement and participation of all students. The protocol is the result of collaboration between the university, business and school, demonstrating how academic research can impact the field and work towards tangible change in tools and intervention methodologies that can provide educational benefits in the medium and long term. Currently, implementing the project locally is still costly, requiring the involvement of many media educators during application and a significant technological provision that involves the purchase or rental of educational robots and tablets by schools. For this reason, the large-scale application of the protocol necessarily requires preliminary teacher training in operational use of the protocol in class. As for the technological provision, government investment in digital and STEAM education for schools can certainly be used for class equipment. The protocol has been presented and integrated into an Erasmus+KA2 European project, coordinated by CISL Scuola, and is currently being applied and tested in four other European countries: Romania, Spain, Portugal and Bulgaria. The international project experience represents an additional opportunity for the Sapienza research group to enhance monitoring and validation tools for the protocol in terms of educational effectiveness, considering the diversity of application in different socio-cultural contexts with equally diverse educational systems.

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