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Critical digital literacy and active citizenship at school: The experience of the Scientix Ambassadors

Digital literacy, senso critico e cittadinanza attiva a scuola: l'esperienza degli Ambasciatori Scientix

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ABSTRACT Quality education represents one of the leading goals among the United Nations sustainable goals and its centrality is internationally recognized. The paper, after reviewing how to reach quality education and which competencies students should reach, presents the Scientix project. With a participatory action research and peer-led experiential learning approach, a number of experiences are shared as a proof of concept about educational intervention coupling research and practices. The experiences cover all school levels and aspects spanning Information Literacies related to online inquiry process and source validation and verification; Data Literacy and its importance for active and critical participation in society; Digital Citizenship and sustainable use of technologies and digital civic engagement and technology use related to Computational Thinking and coding. The work lays the basis for the assessment of key factors in learning resource design and key educational practices with the greatest positive impact on the students' learning path.

KEYWORDS Competencies; Coding; Computational Thinking; Active Digital Citizenship.

SOMMARIO L'istruzione di qualità rappresenta uno dei traguardi principali tra gli obiettivi sostenibili delle Nazioni Unite e la sua centralità è riconosciuta a livello internazionale. Il lavoro, dopo aver esaminato come raggiungere un'istruzione di qualità e quali competenze gli studenti dovrebbero raggiungere, presenta il progetto Scientix. Con una ricerca-azione partecipativa e un approccio di apprendimento esperienziale guidato da pari, l'articolo presenta una serie di esperienze come prova di fattibilità relativa ad interventi educativi che coniugano ricerca e pratiche didattiche. Le esperienze coprono tutti i livelli scolastici e aspetti che spaziano dalle alfabetizzazioni informatiche relative al processo di indagine online e alla convalida e verifica delle

fonti alla Data Literacy e la sua importanza per una partecipazione attiva e critica nella società; dalla cittadinanza digitale e l'uso sostenibile delle tecnologie per un impegno civico digitale all'uso della tecnologia con riferimento al pensiero computazionale e alla codifica. Il lavoro pone le basi per la valutazione dei fattori chiave nella progettazione delle risorse di apprendimento e delle pratiche educative con il maggiore potenziale per un impatto significativo sul percorso di apprendimento degli studenti.

PAROLE CHIAVE Competenze; Coding; Pensiero Computazionale; Cittadinanza Attiva Digitale.

1. Introduction

As suggested by (UNESCO, 2017), quality education is one of the United Nations' sustainable goals and is considered fundamental for reaching all sustainable development goals.

In the attempt to reach quality education, different international frameworks have been proposed related to the competencies students should possess.

Among these frameworks and recommendations, we recall the European Council recommendation for key competencies (Council of the European Union, 2018)[1] that include: Mathematical, science technology, and engineering; Literacy; Digital; Personal, social, and learning to learn; Citizenship; Entrepreneurship; Cultural awareness and expression; Multilingual.

Another global competencies framework comes from the Programme for International Student Assessment framework by the Organization for Economic Co-operation and Development (OECD, 2019). According to the OECD, global competencies should be acquired within a life-long learning journey that is shaped by education. Among the most important competencies, it is possible to recall:

- how to use media platforms effectively and responsibly;
- how to support the Sustainable Development Goals;
- how to live harmoniously in multicultural communities.

The importance of digital technologies for learners is also stated in the European Framework for the Digital Competence of Educators (DigCompEdu) (Redecker, 2017) which indicates that educators should equip their learners with digital competencies related to information and media literacy; communication; content creation; responsible use of digital technologies, and problem solving.

In other frameworks, similar competencies are extended, likewise the DigiComp set of frameworks, to all citizens (Gousetti, 2021; Vuorikari et al., 2022), firms, enterprises and to the whole of society.

Research studies, such as (Clear et al., 2020), have demonstrated how the transition from learning-outcomes-based practices to competency-based practices can be approached.

This work, leveraging on previous experience in research and teaching practice collaborations (Panconesi & Guida, 2017; Maiorana et al., 2020a; Niewint, 2022) aims to share a number of experiences designed and carried out by teachers belonging to a project called "Scientix" aimed at developing some of the above mentioned learners' competencies.

The paper is structured as follows. Section 2 provides background information related to the Scientix project. Section 3 briefly describes the methodology, Section 4 presents the in the field experiences, Section 5 presents a discussion and proposes a roadmap, and finally, Section 6 draws conclusions and highlights further work.

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018H0604(01)&from=EN

2. The Scientix project and the Ambassadors' Community of Practice

Scientix is a European project, whose aim is to promote and support a Europe-wide collaboration among STEM (science, technology, engineering, and math) teachers, education researchers, policymakers, and other STEM education professionals[2].

The project's actions are supported by a European-wide network of "teacher ambassadors", trained and assessed yearly, whose work is "essential for expanding and consolidating a community whose core values reside in sharing good classroom practice, especially in the area of STEM, and making sure that students are equipped with the skills needed to become successful adults".

For the purpose of accomplishing these ambitious goals, the Scientix community is supported by a set of cutting-edge tools, including:

- the Scientix Observatory, a repository of articles, focused on science education;
- the Resource repository, a collection of teaching materials, reports, training courses, and learning materials. It is important to note that all the resources are open access. Moreover, the Scientix project offers a free translation and localization service to all cultures and languages of the European Union, offering inclusive access to quality education material to learners facing language barriers;
- the project Repository, collecting research and teaching information of all the Science Technology Engineering, and Mathematics (STEM) projects funded by the European Union.

3. Methodology

To collect the experiences that are presented in this contribution, one of the authors launched a call within the Scientix ambassadors' community. As a result, a number of them volunteered to engage in a research-based reporting activity to improve their research and teaching practice and to nurture the seed of a self-directed small community of research engaged teachers.

Building on the experience reported in (Maiorana et al., 2022; Maiorana et al., 2020a; Maiorana, 2020b), the process followed the following steps:

1) Call for experiences: topics, and grade band
2) Asynchronous online negotiations on topics and decisions on topics
3) Discussion on a reporting template according to research guidelines such as (McGill et al., 2018)
4) Online sharing of the experience reports which were peer-reviewed
5) Crafting a list of references for reflections and discussions
6) Drafting of the discussion and conclusion with peer review.

Considerable importance was attributed to point 6, encompassing an activity of collaboration, cooperation, and revision among teachers. We know from research that reviewing someone else's work can be a powerful learning mechanism. Furthermore, the exchange of good practices and the comparison of pedagogical ideas with peer colleagues is an effective way to evaluate and develop one's practice and also recognize the different points of view. This has been demonstrated at all levels, from research to daily teaching practice especially in high school and tertiary education (Finkenstaedt-Quinn et al., 2021; Bangert-Drowns et al., 2004; McGill, 2018; Avison, 1999; Swennen, 2020).

Thanks to this process, several experience reports were collected.

This paper summarizes the didactic experiences of a representative sample of the Scientix commu-

[2] https://www.scientix.eu

nity of practice. The activities presented and the contents selected are fully intellectually justified on the condition that recognizes and conceives the existence of the interconnections of knowledge, skills, and competencies with solidarity (Morin, 2000).

4. Results: on the field experiences

In the following, we report some of the Scientix ambassadors' on-the-field experiences. In particular, the described activities cover the following areas:

- climate change;
- sustainability and digital civic engagement;
- hydroponic greenhouses.

4.1. Climate change and digital civic engagement

This experience was conducted during the Covid-19 pandemic in a primary school context for students aged from 8 to 10. It related to climate change and aimed to make the young students aware of the concrete actions they can perform in the context they live: family, school, and social activities with peers. The didactic intervention was designed with an interdisciplinary perspective embracing Italian, Geography, History, Science, Civic Education, Art and Technology. This type of problem-based learning is well suited for any subject area (science and humanities) and also in the social sector of education due to the emphasis produced on real-world problems and the human system. In summary, children were involved in solving problems with authentic experiences within their daily context. Table 1 summarizes the class schedule of the overall activity, which spanned through 8 weeks and included various steps/tasks.

Table 1. Class schedule of the climate activity.

Week	Steps/ Tasks	Resources and tools
1	Climate change issues and our actions to save the planet	Video, Eco-kit
2	The climate change: dictation	Dictation
3	Online inquiry process and reading comprehension, source validation and verification. Creative digital expression	Reflection questions. Electronic devices.
4	Express your view of the planet. Drawing	Paper and colors
5	A weekly data collection and weather report	Paper&pencil, wordprocessor
6	Celebration of World Meteorology Day. Interview grandfather on climate related proverbs. Write and drawing	Exercise book and colors. Tablet.
7	Reflections on activities for energy savings. Choose and motivate how and why we can avoid using electric machines	Exercise books and pencil
8	Celebration of the World Electric Saving Day. Energy and environment protection. How to collect and recycle waste	Interactive games

Week 1- Climate change issues and our actions to save the planet

Activity: Presentation of the topic by watching two previously selected cartoon videos and eco-kit.

The first tells of a child who dreams of experiencing a very hot winter and finds himself without water. The adults gather to make decisions on what to do.

The second tells how our daily behaviours can worsen or improve the conditions of our Earth.

Week 2 - The climate change: dictation

Activity: Dictation of an informative text entitled: "Climate Change". Reading and reflections on the written text.

Week 3. Online inquiry process and reading comprehension, source validation and verification. Creative digital expression

Resources and tools*:* Reflection questions; electronic devices.

Activity: Inquiry process. Reading and reflections on the written text.

Answer the stimulus questions and find information by cutting out images from newspapers or free drawings:

a) Global temperature is increasing. What are causes and effects?
b) What can we do? How and why?

Week 4. Express your view of the planet. Drawing

Resources and tools*:* Paper and colors.

Activity: Inquiry and reflections on questions. Feedback.

The students' reflections are written under their names.

Time for thoughts about drawing.

Topic: Draw in your exercise book how you see planet earth sustaining!

Week 5. A weekly data collection and weather report

Resources and tools*:* Paper & pencil, word processor

Activity: Observation of the weather in a week. Data collection of the climatic conditions every day at the same time and recording in a table.

Week 6. Celebration of World Meteorology Day. Interview grandfather on climate related proverbs. Write and draw Resources and tools*:* Exercise book and colors. Tablet.

Activity: March 23rd is World Meteorology Day! Interview grandfather on climate related proverbs. Write and draw.

"Ask your grandparents or parents for a proverb to remember the day dedicated to the weather. Then write it in your exercise book and draw a picture".

Week 7. Reflections on activities for energy savings. Choose and motivate how and why we can avoid using electric machines

Resources and tools*:* Exercise books and pencils.

Activity: Children are presented with drawings of some household appliances used in homes. Choose an appliance that you think you can stop using and explain why you can do without it. What does energy saving mean?

Week 8. Celebration of the World Electric Saving Day. Energy and environment protection. How to collect and recycle waste

Resources and tools*:* Interactive games.

Activity: Two young UNICEF volunteers discuss the topic of energy and environmental protection. The volunteers present some interactive games and invite the children to behave correctly to avoid waste.

4.2. Sustainability and digital civic engagement

Another interesting experience reported by the Scientix ambassadors came from a project called "Motion on schools" (MOS), which aims to promote good practices on the theme of environmental sustainability, by supporting the use of innovative practices to make students and staff real drivers of change by opting for sustainable mobility choices when they go to school. In Italy this was implemented with the "Pedibus" experience, which is about reaching school on foot in groups, to expand to the sharing of cars from a car-sharing perspective. Smartphones and WhatsApp® are essential for fast and instant messaging that allows participants to respond to last-minute unexpected events and to manage times and stops. Punctuality, courtesy, and mutual respect are essential elements of the itinerary sharing that must be planned and managed by the team. The first moment of the incoming day therefore becomes preparatory to the continuation of the activity at school and has enormous educational value, encouraging a shared seriousness of purpose in management because participants are no longer alone but in a group. The itinerary stops can become anchors of personal and historical memories in a story that accompanies the group while approaching the school and that can be taken up and deepened by the teacher, including in an outdoor space for an emotional closeness or bond to the neighbourhood or the city.

4.3. STEM and coding in hydroponic greenhouses

Another interesting experience came from an experimental project called "Serre idroponiche a scuola", promoted by INDIRE. In this project investigation and modelization are essential elements of the proposed approach, according to which students design an experiment using the scientific method, observe a phenomenon with its variables, collect data, and define a model of the studied phenomenon.

Following this approach, students of a high school in Follonica (Italy) built a hydroponic greenhouse. They started by designing a study about the growth of a plant and measured parameters for one month. Different groups of students measured different physical or chemical parameters. Afterward, using a program like Scratch, students in groups created the forecast model of their data. The resulting modelization showed future scenarios about plant growth, biomass production, or water requirements. Then they compared biological and virtual experiments. In STEAM education this "bifocal method" (Guasti et al., 2023) allows to improve thinking skills and creative skills. The inclusive effect of this work seems to be more impactful than other approaches because every student is involved in assessing their own work and their team's work. Previous studies underline that the bifocal method has also a positive effect on special needs students (Fuhrmanna et al., 2022).

In this experience, the teacher acted as a guide, giving feedback to the team during the work, and motivating every student to develop their skills. Different competencies coming from various STEAM disciplines were somehow required to carry out the activity, such as the scientific method of physics, knowledge of biology, coding in informatics to create forecast models, etc. Creativity was developed at each step of the activity because students wrote web diaries to show data and observations and communicate with each other (Salehi et al, 2013).

5. Discussion

All the reported experiences are characterized by innovations in content, pedagogies, and technologies, according to the TPCK framework (Archambault & Barnett, 2010).

The content innovation came from exposing students to real-life problems in all school grades. In line with the OECD "Recommendation of the Council on Creating Better Opportunities for Young People"[3], the above experiences can be considered examples of youth engagement with global challenges, such as climate change and digital technologies.

The innovation in pedagogies came from the Inquiry Based approach, which characterized all the activities and is typical of the Scientix community; this was coupled with a problem, project, and challenge-based approach. Moreover, creating a class climate of mutual care (Maiorana et al., 2022; Freire, 2002; Ko, 2021) was considered of paramount importance: even if it required a consistent amount of time and energy, it contributed to the development and promotion of social inclusion and youth well-being, both considered building blocks by the OECD recommendations. These pedagogies also improved the quality of communications at all levels, in line with the Manifesto of Non-Hostile Communication used in several contexts such as (Cristaldi, 2022; Giuliani, 2023), according to which developing a kind approach to conflict resolution is the best strategy to support young people's engagement in social action.

Finally, innovation in technologies came from the use of cutting-edge technological tools to support communication, collaboration, learning scenario design, and domain specific needs typical of the disciplines.

6. Conclusion and further work

This work, leveraging on authors' extensive practice as educators and researchers, proposes a set of experience reports rooted in research, nurtured through the Scientix ambassadors' community and involvement in several projects both inside the Scientix community and directly led by the ambassadors. The experience reports are related to several domains of the new critical digital literacies framework: technology use, data and information literacy, and digital citizenship. The age range of the students involved in the reported experiences covers the whole school path from primary to secondary schools.

As a further step, we plan to evaluate the use of the proposed interventions through

– a) student pre and post-tests;
– b) student self-assessment;
- c) end of activity student surveys.

We will collect qualitative and quantitative data and compare them with a control group when possible. This further study aims to distill best practices for designing, developing, and deploying learning activities to maximize the impact on students' progression through achieving critical digital literacy competencies.

[3] https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0474

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