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Learning Sciences from the Past: Recovery, Study, and Cataloging of a Historical Natural History School Museum

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Abstract: School–museum partnerships have gained considerable attention in the academic literature in recent decades. However, their role in enhancing science education is still an under-researched topic. This work reports on the outcomes of the recovery, study, cataloging, and valorization of the 18th century geo-mineralogical collection belonging to the Collegio Nazareno, now housed at the Istituto San Giuseppe Calasanzio in Rome. The project, which was participated in by the students enrolled in the fourth- and fifth-grade high school classes, revealed rare specimens such as the mineralogical collection donated by the Holy Roman Emperor Joseph II (1741–1740) in 1785. Furthermore, the laboratory activities organized from the stored samples highlighted educational approaches that helped students to cope with the complexities of authentic scientific work and cultural related issues. This work thus offers significant insights into the importance of natural history school museums as useful (and oft-forgotten) learning tools in science education.

Keywords: school heritage; science education; laboratory activities; cataloging; Collegio Nazareno; earth sciences literacy

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1. Introduction

The academic literature has used the term scientific literacy (or science literacy) with different meanings for more than seven decades since this expression appeared in the 1950s, e.g., [1,2]. As Brickhouse [3] pointed out, being scientifically literate in contemporary society deals with acquiring scientific knowledge and achieving all the skills necessary to exercise informed citizenry in the technical challenges of everyday life. So, it is not surprising that diverse scholars, such as Falk et al. [4] and Panitsidou [5], consider scientific literacy to be a lifelong learning process occurring in formal, non-formal, and informal environments, e.g., [6–9]. In recent years, there has been an increasing number of studies describing out-of-school learning, e.g., [10], as a complement to formal education for STEM (Sciences, Technology, Engineering, and Mathematics) disciplines, e.g., [11–17]. As Reis [18] (p. 218) pointed out, within formal education in European secondary schooling, earth sciences are frequently scattered through other teachings and usually do not represent an individual subject. In this regard, Korkmaz and Altinsoy [19] highlighted how African countries have been experiencing a shortage of science teachers since the 1950s, and thus, providing geology education in schools can be challenging. The authors [19] then noticed that geology education is limited and overlooked in the school curriculum even in countries with more resource-efficient economies, such as Greece and the United Kingdom. On this subject, Reis [18] also outlined that students are not inclined to attend geology courses even in those countries (e.g., Portugal), offering them as separate options in high school curricula. A result of this situation, as evidenced by Remmen and Frøyland [20], is that students of all ages struggle with the understanding of rock and mineral nature and their classification.

Regarding the Italian scenario, high schools and technical institutes offer geology education and the natural sciences curricula with biology and chemistry. This situation contributes to the worsening of the so-called scientific vocation crisis (*crisi delle vocazioni*

scientifiche) [21,22], i.e., a global phenomenon, e.g., [23,24], concerning the low enrollment of students in scientific degree programs. Figure 1 shows the steady decrease in enrollment Italian geology programs have been experiencing since 2010. Despite the launch of the National Geology Plan in 2016, a project through which universities interact with secondary schools [25], only 798 students enrolled in undergraduate geology courses for the 2022/2023 academic year nationwide [26] (Figure 1).

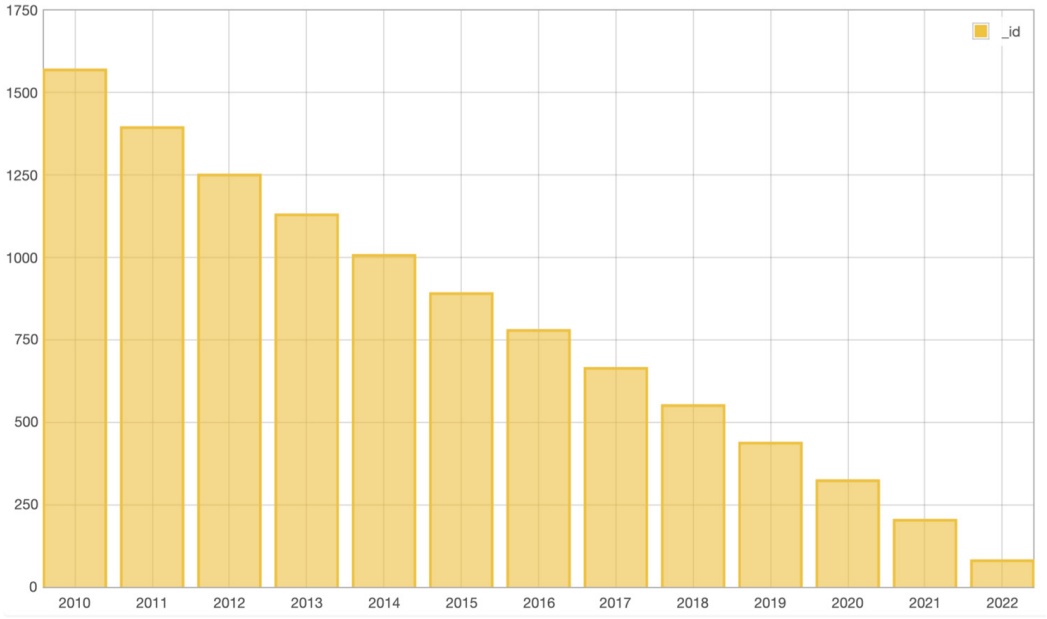

Figure 1. Enrollment of students in Italian geology degree programs since 2010.

From the data in Figure 1, it is pertinent to ask if geology education is still a relevant topic in scientific literacy. On this subject, Korkmaz and Altinsoy [19], quoting Gogoi et al. [27], argued that geology education is crucial for the sustainable exploitation of underground resources. It also provides students with a broad and deeper understanding of geodiversity (including the risk mitigation of natural hazards), and geoheritage, while developing different thinking skills such as deep time dimension, spatial, and cycling thinking, e.g., [28,29]. Furthermore, geological knowledge raises awareness of geoethical issues such as waste disposal and climate change, e.g., [30,31].

In her review of the geoscience education literature, Van der Hoeven Kraft [32] stated that students' interest tends to be triggered by an external agent that needs to be repeated, engaging, and intellectually stimulating to be developed into a sustained individual interest. Therefore, carrying out experiences in museum contexts can help enhance learning and engagement in sciences.

Much research has been published on the connections between schools, museums, and science education. Studies since the 1990s, e.g., [33–39], have emphasized the role of science and natural history museums as non-formal learning environments to enhance scientific literacy, e.g., [40–51]. On this subject, Reis [18], Mikhailova et al. [52], and Mujtaba et al. [53] highlighted the use of geo-mineralogical museum collections to support students' learning and engagement in earth sciences. In this regard, it has to be noted that secondary schools often have disused natural history teaching collections, usually dating back to the 18th century, which can be recovered and then used as didactic tools for laboratory activities.

This work aims to highlight the importance of the correct preservation and valorization of natural history school collections and their effectiveness as teaching tools in laboratory activities. In the pages that follow, the recovery of the 18th century geo-mineralogical collections belonging to the Collegio Nazareno of Rome will be described. The latter is now kept in the Istituto San Giuseppe Calasanzio, a private institution run by the Piarist fathers that comprises classes from kindergarten to high school.

This study adopts a case study approach based on STEAM (Science, Technology, Engineering, Arts, Mathematics), e.g., [54,55], laboratory activities held in natural history museums and science centers. Within this methodological framework, secondary school students and teachers of the Istituto San Giuseppe Calasanzio attended the activities concerning the arrangement of the new exhibition, storage area, and cataloging of the collected specimens. All the activities presented in the current study were designed using an object-learning-based approach. This method is particularly useful in studying and working on disused natural history teaching collections since object handling, as remarked by Hannan et al. [56], fosters the learning process in various educational contexts, especially schools. In this regard, the authors [56] underlined that over the last forty years of pedagogical literature, active and experimental learning became dominant in education, since evidence suggests that the principles of object-based learning contribute to gaining educational goals in students of all ages, disciplines, and levels of progression.

This paper has been divided into six parts. Section 2 illustrates a brief overview of the school museum concept. The state of the art of Italian school heritage is presented with a focus on the rediscovery of 18th and 19th century scientific and natural history teaching collections within national and compulsory after-school activity programs. The usage of Collegio Nazareno's geo-mineralogical collections as didactic tools from the establishment of the Mineralogical Cabinet in the 18th century until the first decades of the 20th century is also described. Section 3 deals with the recovery, cataloging, and valorization of Collegio Nazareno's geo-mineralogical collections now housed at the Istituto San Giuseppe Calasanzio. Section 4 presents the research findings, focusing on the key themes (e.g., cataloging campaign) discussed in Section 5. The latter analyses the main research findings focusing on the STEM/STEAM laboratory activities performed from the cataloging records (e.g., PCTO activities). The feedback obtained by students and teachers during the round table ending the project is also reported. Finally, the scientific school heritage cataloging status, using ICCD standards, is presented for the first time. The study conclusions are summarized in Section 6.

The present research explores new usages of disused natural history teaching collections in secondary education. The project employs an object-based learning approach focusing on the recovered rock and mineral specimens to support and expand the geological and historical contents illustrated in the school programs. Cross-disciplinary pedagogic applications for ancient natural history school collections within STEAM laboratory activities are also established.

2. Background

2.1. School Museums: A Brief Overview

There is little available research in the literature on school museums (in general) and science education (in particular). In her pioneering work, Smith [57] defined a school museum as a collection of objects providing an element of wonder, usually used in hands-on activities to facilitate a child's understanding of the realities of life. According to the author [57], school museums thus represent valuable tools in teaching science to generate scientific interest and stimulate the learning processes. It is then worth mentioning that Smith [57] stressed the importance of the correct materials' care, preservation, and interpretation (e.g., supplying the objects with labels).

Regarding their origin, historians, e.g., [58,59], dated the first school museums—except for a few ones established in the pedagogic context of the experimental learning promoted by Johann Heinrich Pestalozzi (1746–1820), e.g., [60]—as an international phenomenon emerging in the second half of the 19th century during the temporary exhibitions on education and upbringing during the world's fairs. Usually housed in primary and secondary schools, these museums displayed teaching materials and collections on local history and natural sciences. Usually housed in primary and secondary schools, these museums displayed teaching materials and collections on local history and natural sciences. In this regard, it is interesting to note that natural specimens, as highlighted by Newman and

Driver [61] (pp. 1223–1124), were supplied not only by teachers and parents but also by collectors, traders, municipal authorities, and missionaries. Moreover, the management of natural science collections was characterized by curation practices, including a rational mode of acquiring and displaying the specimens (e.g., unambiguous labeling, avoidance of duplicates, visual clarity, and accessibility) and by strategies to prevent damages due to agents of deterioration and careless handling [62,63]. Despite their increasing significance as valuable resources for object-based teaching and learning—to the point that they became travel destinations in educational tours, e.g., [64]—the shortage of classroom space and the lack of human and economic resources, together with the increasing importance of school visits to scientific exhibitions, has led school museums, as stated by Newman and Driver [61] (p. 1230), to progressive disuse since the 20th century.

The abovementioned factors can also be listed as the causes of today's non-recovery and valorization of school collections. These processes result in the inevitable and progressive loss of a unique scientific, educational, and historical heritage that can occasionally be saved if it is merged into collections belonging to natural history museums—e.g., the teaching mineralogical collections of the Florentine Istituto Superiore di Magistero (comprising more than 465 specimens) acquired by the Natural History Museum of Firenze in the 1930s [65] (p. 22)—or to educational museums such as the National Pedagogical Museum in Madrid, e.g., [66].

2.2. School Heritage in Italy: Where Are We Now?

Regarding the Italian scenario, which represents the geographical and cultural background of this work, it is interesting to note that contemporary historiography, as stated by D'Ascenzo [67,68], considers the Italian school museums developed since the 19th century, e.g., [69–71], as a historical-educational heritage (also called school heritage [72]). The latter comprises not only teaching collections but also libraries and archives, e.g., [73–75], which still need to be correctly preserved and made known to students and teachers. To achieve this goal, Meda and D'Ascenzo [67,76] underlined the establishment of educational museums, mostly based on academic institutions [77], entirely devoted to preserving and displaying the school heritage such as the Museo della Scuola e dell'Educazione "Mauro Laeng" in Rome, e.g., [78], the Museo dell'Educazione in Padua, e.g., [79], the Museo della Scuola e del Libro per l'Infanzia in Turin, e.g., [80], the Museo Didattico e della Didattica in Piacenza, e.g., [81], the Museo della Scuola "Paolo e Ornella Ricca" in Macerata, e.g., [82,83], and the Museo della scuola e dell'educazione popolare in Campobasso, e.g., [84]. Furthermore, it is noteworthy the establishment of the Italian Society for the Study of the Historical-Educational Heritage (Società Italiana per lo Studio del Patrimonio Storico-Educativo, SIPSE) in 2017, aiming to recover, safeguard, and make accessible to scholars and the general public the school heritage kept in local museums, centers for documentations, and educational institutions, e.g., [85,86].

2.3. Rediscovering Scientific and Natural History Teaching Collections: Lights and Shadows

Regarding the scientific school teaching collections [87], diverse projects have focused on recovering and valorizing of instruments in disused school laboratories, e.g., [88–94]. The experiences are carried out within the National Plan for Scientific Degrees (Piano Nazionale per le Lauree Scientifiche, PNLS), i.e., a project established in 2014 by the Italian Minister of University and Research to enhance enrollment in science degree programs through work-based learning experiences performed in closed collaboration between teachers, secondary school students, and academic researchers, e.g., [95]. PNLS is therefore strictly connected to the Third Mission of the universities (TM), which represents, as stated by Compagnucci and Spigarelli [96] in their literature review, the progressive engagement of academic institutions in activities aiming to contribute to the social, economic, and cultural development of the geographical areas in which they are based, by transferring knowledge and technologies to industry and society. Furthermore, PNLS activities are part of the mandatory National Plan for Soft Skills and Guidance (Piano per le Competenze Trasversali e l'Orientamento, PCTO),

e.g., [97], previously known as School-Work Alternation (Alternanza Scuola-Lavoro, ASL). PCTO involves students (post-16 years old) enrolled in the last three years of the secondary education system for at least 90 h of activities to help them make informed choices about their future careers. Even if the experiences mentioned above regarding the valorization of scientific teaching school collections focused on the recovery of historical instruments, other projects involved natural history collections, which are primarily preserved in civic and university museums, e.g., [98–105].

However, PCTO experiences are insufficient to ensure a proper inventory, recovery, and valorization of the entire Italian educational heritage, especially when natural specimens are kept in private institutes and religious schools. In this regard, it must be noted that, despite the centuries-old tradition in science and education usually held by these institutions, their natural history collections—and the relevant archival documentation—often remain unknown to scientists, pedagogists, museologists, and historians. This is true in the case of the 20th century zoological collection belonging to Barnabite Fathers in Naples, which, as outlined in Adamo et al. [106], has never been the subject of extensive studies and cataloging. Furthermore, no longer being used as teaching tools, these collections frequently lie in poor conservation conditions.

2.4. Natural History Museums and Earth Sciences Education

As reported earlier, natural history museums are non-formal learning environments suitable for organizing multidisciplinary educational laboratories aiming to increase creativity. As stated by Aguilera and Ortiz-Revilla [55], creativity is one of the key aspects of STEM education since the interdisciplinary nature of STEM disciplines fosters students' problem-solving skills from different perspectives. This view is also reconfirmed in STEAM education, where the inclusion of humanities in the teaching–learning process improves students' creativity [107].

Diverse studies have investigated the role of STEM teaching approaches in geology education, for example, spatial thinking, e.g., [108–110], and fieldwork experiences, e.g., [111–114]. As evidenced by Reis [18], Jakubowski [115], and Pasquaré Mariotto and Venturini [116], natural history museums, besides enhancing public awareness of geoheritage, are key non-formal learning environments to boost earth sciences literacy. Geo-mineralogical collections bear not only unquestionable scientific importance but also educational value, thus playing a pivotal role in establishing interdisciplinary pedagogical itineraries with the collected specimens. In this regard, Thogersen et al. [117] acknowledged museum objects as effective educational tools due to their dual character: on the one hand, they are observable and immutable, but on the other, they can be re-contextualized and re-interpretated according to different values depending on visitors' everchanging knowledge systems.

A detailed investigation of object-based learning in higher education is presented by Chatterjee and Hannan [118]. Regarding the relationship between earth sciences education and object-based learning in natural history museums, it has to be noted that geo-mineralogical specimens provide a focal point for acquiring specific knowledge. Scientific observation and hands-on activities using rocks and minerals are central in classroom inquiry since they allow students to learn theoretical and practical notions on classifying geo-mineralogical samples, their properties, and related geological processes, e.g., [119,120]. As suggested by Chatterjee [121], geo-mineralogical museum specimens can be used in many ways to facilitate the acquisition of appropriate scientific language, team work, practical and observational skills. Laboratory activities comprising geo-mineralogical museum specimens foster STEM and STEAM education promoting geoconservation and environmental education awareness in students. Geo-mineralogical collections may include type specimens, samples that are legally protected or assigned for conservation at a national/international level, specimens from localities, mines, and deposits that ran out and thus are no longer visible and collectible, unique or rare samples (e.g., well-formed minerals and extraordinary association of mineral species) carrying aesthetic, scientific, historical,

and cultural value, and samples related to prominent scientists and collectors, which can also deal with the history of geological discoveries and explorations [115] (pp. 24–26). Furthermore, these kinds of STEM/STEAM laboratory activities encourage students' feelings related to care and sensemaking through practices involving observation, thus expanding the range of resources valued for science learning [122].

3. Materials and Methods

3.1. The Geo-Mineralogical Collections of the Collegio Nazareno's Mineralogical Cabinet

The geo-mineralogical collections kept at the Instituto San Giuseppe Calasanzio of Roma date back to the second half of the 18th century when they began to be assembled to establish the Mineralogical Cabinet within the Collegio Nazareno, one of the oldest Roman schools, founded by Giuseppe Calasanzio (1557–1648) in 1630 [123] (Figure 2).

Figure 2. 18th century view of the Collegio Nazareno.

Collegio Nazareno represented a cultural center within the frame of Roman scientific academies since it was open to the influences of Jansenism and the Enlightenment [124,125] and characterized by teaching programs focused on enhancing scientific learning. As stated by Maddaluno [126] (p. 108), the Collegio Nazareno flourished in the 1780s under the rectorate of Father Giovanni Vincenzo Petrini (1725–1814), who founded the Mineralogical Cabinet, whose collections were enriched over the years by well-renewed naturalists, e.g., Scipione Breislak (1750–1826), Carlo Giuseppe Gismondi (1762—-1824), and William Thomson (1761–1806); members of nobility, e.g., the Prince of Cerveteri, Francesco Maria Ruspoli (1752–1829) and the Elector of the Palatinate, Karl Theodor (1724–1799); and popes and prelates, e.g., Pious VI (1711–1799) and the Cardinal Stefano Borgia (1731–1804). These donors, along with many others, were listed in the Catalogo dei Benemeriti (Benefactors' catalog), which was contained in Petrini's Gabinetto *Mineralogico del Collegio Nazareno* (Collegio Nazareno's Mineralogical Cabinet), a two-volume treatise on mineralogy Petrini written between 1791 and 1792 starting from the description, analysis, and classification of Collegio Nazareno's geo-mineralogical collections [127] (pp. 23–28). The Mineralogical Cabinet was firstly a research center and a teaching tool for Collegio Nazareno's students. Here, mineralogical and chemical classes were held, and students practiced using the specimens in the collections. Furthermore, it is noteworthy that the lectures given by Gismondi were open to the public since he believed that a private institution aimed to

serve public education [128]. The Mineralogical Cabinet prospered since the first half of the 20th century thanks to the work of Piarist Fathers such as Adolfo Brattina (1852–1935), who held practical classes in mineralogical analysis, especially on silica minerals and quartz mineralogical associations with sulfides and sulfosalts [129] (p. 19) using the specimens kept in the cabinet. This brief overview thus outlined how Collegio Nazareno's geo-mineralogical collections were used in teaching and learning activities within a more extensive background of scientific and sociocultural practices [130]. After the mid-1950s, the geo-mineralogical collections lost their role as a learning tool and gradually became disused, thus leading to the progressive decay of the specimens' conservation state. In early 2012, the collections were transferred from the historical location of Palazzo Nazareno to the Istituto San Giuseppe Calasanzio [131].

3.2. The Project

After moving to the Istituto San Giuseppe Calsanzio, a small part of the surviving specimens was placed in wooden and glass cabinets in front of the Father Pusino school theater on the ground floor of the institute. At the same time, most were stored in plastic boxes together with their original handcrafted wooden cassettes used to display them in the past, in the basement. The latter presented paper labels showing the specimens' inventory numbers and their mineralogical classification (Figure 3).

Figure 3. A specimen of calcite (Inv. n. 588, weight 377g) coming from Volterra (Tuscany, Italy). The sample is placed in the original handcrafted wooden box used to display it at Collegio Nazareno's Mineralogical Cabinet. The paper label reported the historical inventory number, mineralogical species, and specimen's provenance.

Both the labels and the wooden boxes showed various conservation conditions. In particular, the cassettes containing sulfides and their associated labels presented the most significant degree of alteration, resulting in the formation of sulfates.

The project of recovery, study, and valorization of the Collegio Nazareno's geo-mineralogical collections, in which the fourth and fifth grades of the local Scientific and Foreign Language High Schools also participated, started with securing all specimens found in the area in front of the school theater and the basement. In this regard, the samples in the basement were at the greatest risk of damage, loss, and breakage because they were stored in unsealed plastic bags and thus exposed to agents of deterioration such as dust and pests.

All the recovered samples were photographed using a DSLR camera, a still-life table, LED lights, and a scale cube. UV lights were used to decipher labels on the specimens' surface, usually reporting the inventory number, in poor conservation conditions. The specimens were included in an offline electronic database comprising their weight and historical mineralogical identification as noted in the Mineralogical Cabinet's inventory, drawn by the natural sciences professor Augusto Zanotelli in 1898, now kept in the Historical Archive of the Collegio Nazareno. In this regard, it has to be noted that the database was completed with the information retrieved by diverse types of paper labels, showing inventory numbers and often overlapping, found on most specimens. After completing the inventory process, a cataloging campaign using the national standards issued by the Istituto Centrale per il Catalogo e la Documentazione (Central Institute for Cataloging and Documentation, hereafter ICCD), which is part of the Ministero della Cultura (Italian Minister of Culture, MiC), was launched to study and valorize the specimens. The catalographic standards devoted to the catalog of Italian natural heritage consist of seven models regarding minerals (Beni Naturalistici-Mineralogia, BNM) [132]; paleontological, botanic, and zoological specimens (Beni Naturalistici-Paleontologia, BNP; Beni Naturalistici-Botanica, BNB; Beni Naturalistici-Zoologia, BNZ) [133–135]; human remains found in archeological contexts and anatomical preparations kept in morbid anatomy museums (Antropologia Fisica, AT) [136]; meteorites (Beni Naturalistici-Planetologia, BNPL) and rocks (Beni Naturalistici-Petrologia, BNPE) [137,138]. Since the specimens recovered at the Instituto San Giuseppe Calasanzio comprised only minerals and rocks, the BNM and BNPE standards, described in Pratesi and Franza [139], were used. The catalog datasheets were compiled on the online platform SIGECweb [140], and the resulting records were published in Open Access (OA) on the General Catalog of Cultural Heritage (Catalogo Generale dei Beni Culturali, CGBN) database [141].

3.3. Participants in the Project

The project of recovery, cataloging, and valorization of the 18th century geo-mineralogical collections belonging to the Collegio Nazareno's Mineralogical Cabinet and now housed in the Istituto San Giuseppe Calasanzio was elaborated within the Italian Ministry of University and Research under the Dissemination of Scientific Culture Project (legislative decree 10 January 2000), which is an Italian funding program to support the institutions committed to the dissemination of scientific culture and to contribute to the preservation and valorization of the scientific and technological heritage in the country [142].

Therefore, the main actors of the project are the University of Firenze as the scientific leader of the project and the cataloging campaign, the Istituto San Giuseppe Calasanzio represented by the Priarist Fathers and the high school principal, and the teacher and student population involved in diverse parts and activities of the project. In this regard, all the teachers of the middle and secondary school participated in the informative workshop on the project, The teachers of science, history, and German language (N = 4) were directly involved in STEM/STEAM laboratory activities. The students participating in the project attended the fourth and fifth grade of the Science and Foreign Languages High Schools (N = 53) participated in the arrangement of the new exhibition and storage areas, including the samples handling and deciphering the ancient museum's tags and inventory labels, challenging themselves with understanding ideas and values (e.g., conservation and valorization of school heritage) that were previously unknown [143]. Curatorial practices can be considered, as outlined by Butler and Lehrer [144] (p. 5), as effective methodological resources embracing, for example, pedagogy, creative expression, dialogue with different agents (e.g., teachers, peers, experts in the field) to reflect on social and cultural concerns regarding natural history school heritage. As discussed above, the latter often lies in a space of invisibility [145] and thus needs to be made tangible and visible by re-establishing its public performance [146]. Concerning the case study presented here, the legitimacy of the geo-mineralogical collections preserved at the Istituto San Giuseppe Calasanzio consists of recovering their pedagogical function as learning tools for science education.

4. Results

The project concerning the recovery and study of the 18th century geo-mineralogical collections belonging to the Collegio Nazareno in Rome and now housed at the Istituto San Giuseppe Calasanzio retrieved 1724 specimens. Due to the poor storage conditions, diverse specimens (ca. 100 units) were treated with basic conservation remedies [147], such as manually removing dust and decay products (Figure 4).

Figure 4. Inv. n. 1300 described in Zanotelli's historical inventory (1898) as a sample of blende with galena (weight 402 g). The figure illustrates the specimens before and after manually removing dust and decay products.

Sixteen asbestiform minerals were double-bagged in heavy plastic bags to minimize the health risks.

All the recovered specimens were inventoried in an offline database to be used by science and history teachers to program cross-curricular learning activities. Two hundred specimens were cataloged using the BNM and BNPE national standards on the SIGECweb platform, and the records were published in OA on the General Catalog of Cultural Heritage database. The most striking result from the cataloging campaign was the recovery of 59 specimens belonging to the mineralogical collection donated to Collegio Nazareno's Mineralogical Cabinet by the Holy Roman Emperor Joseph II (1765–1790) in 1785. These specimens and other 250 geo-mineralogical samples taken from the deposit were displayed in the new exhibit area, as shown in Figure 5.

Figure 5. New permanent exhibition of the 18th century mineralogical collections that belonged to the Collegio Nazareno and are now housed at the Istituto San Giuseppe Calasanzio. The four central showcases show the surviving specimens donated by the Holy Roman Emperor Joseph II in 1785. (wide-angle photo).

Regarding the design of a new and secure storeroom, an area equipped with stackable plastic containers for the long- and short-term storage of geo-mineralogical specimens was arranged in front of the Father Pusino school theater. Finally, a new permanent exhibition area was designed on the Istituto San Giuseppe Calasanzio ground floor.

Fourth- and fifth-grade secondary school students were actively involved in arranging the new exhibition area and the deposits, except for securing the asbestos samples for safety reasons. Students' engagement is illustrated and discussed in the next section, together with the PCTO activities concerning cataloging of rock and mineral specimens kept in the storage area according to the ICCD national BNM and BNPE standards.

A workshop for the teachers working at the Istituto San Giuseppe Calasanzio was organized to illustrate the project's key findings and the possible learning activities to be performed using the recovered geo-mineralogical specimens and the catalog records. Finally, a round table involving students and teachers was held to discuss the importance of preserving natural history school collections in a multidisciplinary perspective.

5. Discussion

This study assessed the importance of preserving and valorizing disused natural history collections in schools, particularly private and religious institutes. The project aimed to recover and make accessible to teachers, students, and the general public the 18th century geo-mineralogical collections that belonged to the Mineralogical Cabinet of the Collegio Nazareno and are now kept at the Istituto San Giuseppe Calasanzio of Roma. It was found that 1724 geo-mineralogical specimens and related archival documentation (i.e., paper labels attached on the specimens' surface and the original display wooden boxes) were kept in poor conservation conditions since the collections were no longer used as didactic and research tools from the second half of the 20th century.

Another finding that stands out from the results reported earlier is the discovery of 59 massive specimens comprising rocks and minerals given to Collegio Nazareno's Mineralogical Cabinet by the Holy Roman Emperor Joseph II. This donation, as outlined in Mottana et al. [148] and Mottana [149], dated back to 1785 and was briefly described by Petrini in the preface to the first volume of his mineralogical treatise [127] (p. 25). The specimens' identification was made possible by the retrieval of paper labels showing, on their upper side, the printed Latin wording «Ex Munificentia Josephi. II. Rom. Imp. Aug.» and the double-headed eagle representing the House of Habsburg coat of arms (Figure 6).

Figure 6. A cinnabar specimen coming from the historical region of Dacia. The sample is part of the collection Holy Roman Emperor Joseph II donated to the Mineralogical Cabinet of the Collegio Nazareno in 1785 (Inv. n. 1458, weight 1973 g).

As outlined in Franza and Pratesi [150], these specimens are the only ones that can be currently attributed with certainty to Joseph II since no other mineralogical samples (preserved, for example, at the Naturhistorisches Museum in Vienna, where the Habsburg natural history collections are kept) reported the same labeling or any other distinctive mark related to Joseph II. Concerning the cataloged specimens using the BNM and BNPE national standards belonging to Joseph's II donation, what stands out is their exclusive provenance from today's Austria, Hungary, Slovakia, and Romania and rock samples from the Austrian territories. For instance, Petrini [127] (p. 68) underlined that the numerous «yellow pyrite» specimens coming from today's abandoned mine of Smolnik (Slovakia) entered the Mineralogical Cabinet thanks to the «royal munificence of Joseph II.»

As stated by Allen [151], designing a scientific exhibition is a constructivist dilemma since the display is an effective teaching tool if it facilitates immediate apprehension and visitors' physical interactivity while showing a conceptual coherence granted by the results of a strong research program during its design processes. Therefore, all the data retrieved by the cataloging campaign guided the arrangement of the new exhibition on the ground floor of the Istituto San Giuseppe Calasanzio. Before the renovation, the area in front of the school theater was used for the kindergarten canteen during the COVID-19 pandemic. The new exhibition includes ten high-specialized showcases to display the mineralogical specimens (Figure 5). The first three exhibit the aesthetic minerals retrieved from the historical surviving samples. These display cases thus represent useful teaching tools for middle school students, who can learn, for example, about the phenomenon of color in minerals and its importance in identifying mineralogical specimens [152]. The following four showcases are devoted to the exhibition of the surviving samples comprising the collection donated by Joseph II to the Mineralogical Cabinet of the Collegio Nazareno. The specimens are displayed together with new museum tags showing the historical mineralogical identification and associated inventory number. If the Habsburg original label is detached, it is placed next to the sample. This exhibition design was adopted to promote cross-cultural learning [153] since science and humanities teachers can organize learning activities based on a humanistic approach to science education [154], comparing, for instance, the historical mineral naming (e.g., blende) and its modern characterization.

Starting from this information, science teachers can organize learning activities involving directly observing the minerals to identify the modern names while explaining the historical ones. Furthermore, activities focusing on the history of mining, technology, and people in the 18th century Habsburg domains can be offered to high school students using the data retrieved from the cataloging campaign. Finally, the last three showcases display the most scientifically interesting rock samples. In this regard, diverse specimens from Roman and Latium mines are noteworthy since they represent helpful nature-based objects to teach local mining history starting from primary schools, thus helping to develop a sense of place between pupils and students [155–157]. The activities mentioned above and the compilation of new cataloging records on the stored specimens can be the topic of the brief essay students have to prepare for their high school graduation exams. As suggested by Colletti [158,159] concerning physics education, multiple cultural contexts can positively contribute to promoting geo-mineralogical sciences, even among students who do not plan to pursue a career in science. The display cases are then interspersed with four educational panels, easy-to-read and drawn using text characters readable also by visually impaired people, which report a brief history of the Collegio Nazareno's Mineralogical Cabinet, notes on Habsburg mineral collecting, a comprehensive reconstruction of events surrounding the donation of the mineralogical collection from Joseph II to the Collegio Nazareno in 1785, and a detailed explanation of the exhibition setting.

Students attending the fourth and fifth years of high secondary school at the Istituto San Giuseppe Calasanzio were actively involved in the arrangement of the new exhibition. In the first part of the design exhibition project, they viewed all the recovered specimens, expressing amazement that they were unaware of the historical and scientific importance of the minerals and rocks stored in the old cabinets in the area in front of the school theater. Subsequently, they were informed about the overall topics of the exhibition (i.e., aesthetic minerals, Joseph's II mineralogical collection, relevant scientific and historical specimens, rocks coming from Rome, its suburbs, and the Latium region). These themes were discussed with teachers and the experts using guiding questions [160]. Most of the students and teachers praised the display of local and regional minerals since it represented a zero-cost indoor geological activity to understand urban geology, its diversity, and the use of rocks as heritage stones in Roman architecture and society.

Under the supervision of teachers and experts, students placed most of the selected specimens in the new display cases. In this regard, it has to be noted that students expressed a negative opinion on the arrangement of all the samples belonging to Joseph's II donation with the historical tags facing visitors. Students observed that such a layout would have distracted the visitors' attention from the displayed specimens since, as remarked by Serrell [161] (p. 33), design plays a crucial role in museum exhibitions not just in presenting contents, but in creating them.

In the second stage, students were involved in the reorganization of the new storage area, which was arranged according to the RE-ORG, a methodology for reorganizing museum deposits comprising less than 10.000 specimens developed by UNESCO and the International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM) [162,163]. Students were given a self-evaluation format to identify the most urgent problems under the experts' guidance. The most pressing issues were locating a suitable space and finding new sample storage containers. Therefore, the deposit was organized on the ground floor of the Istituto San Giuseppe Calasanzio, and the students were involved in the storage of the samples using zipped plastic bags to avoid agents of deterioration (e.g., pests and water). The ancient display boxes were also bagged and placed in separate containers, while detached labels were placed in acid-free paper for archival storage.

As stated by Kampschulte and Parchmann [164], developing an exhibition with students requires multiliteracy and inquiry-based learning skills since they experience authentic scientific work, teamwork, problem-solving, and project management issues. Furthermore, as Reis et al. [165] outlined, the organization of museum exhibitions made by

students highlights borderline topics. In this case study, the main theme is rediscovering forgotten school heritage. About this subject, Whitehead [166] argued that the organization of display areas promotes the development of different knowledge and narratives such as the rediscovery of the Istituto San Giuseppe Calasanzio's collecting and scientific history. This activity also strengthens the relationship between students and teachers while enhancing the importance of science education related to cultural issues.

In the round table organized during the workshop aimed to illustrate the project's findings, the fourth-grade student who included in his PCTO activity plan the cataloging, using the BNM and BNPE national standards, of rock and mineral specimens kept in the storage area gave a communication on his experience. Firstly, he attended classroom-based training courses regarding the ICCD cataloging standard procedures, focusing on using geographic information systems [167] and the SIGECweb platform. These preliminary activities, held by academics and experts in the field, were mandatory to acquire the basic theoretical and empirical knowledge to compile cataloging records according to the ICCD national procedures. Furthermore, the topics presented in the lectures covered one of the main PCTO goals, i.e., enhancing informative literacy in high-school students [168] (p. 59).

Subsequently, the student went to the storage area and, by checking the internal offline database, chose three minerals and three rocks of his particular interest. After a guided discussion with the experts, the student decided to compile the cataloging datasheet at a pre-catalog (P) level. The cataloging activities started by photographing the samples using the equipment described in the Materials and Methods sections. The resulting images were uploaded on the SIGECweb within the FTA paragraphs (photo documentation), a cross-section on the different ICCD national standards. The student then weighed the specimens and collected all the information that could be obtained by their direct observation and handling, such as the presence of ancient museum tags and labels, inscriptions, and damage due to their poor conservation status. These data were entered in the SME (labels and tags), MT (technical data), DA (analytical data), and CO (conservation status) cross-sections. In this regard, it is noteworthy that, after discussing with the experts, the student suggested guidelines for a more proper preservation of the specimens in the STCS and STCM subsections. Furthermore, the critical analysis of the retrieved data, carried out with the help of the experts, led the student to identify information related to the provenance of the samples, including mines, deposits, and the usage of ancient mineral names. These data were listed in LR, IMAM, and RM cross-sections. The specimens were observed with a microscope to describe their physical features and properties. The resulting data were entered in the mineral and petrography systematics sections (i.e., SM and SR paragraphs in BNM and BNE cataloging standards).

Then, the student was engaged in informal activities, e.g., [169], like conversations with the experts, to evaluate appreciation. It was found that he appreciated the possibility of observing historical specimens of rocks and minerals besides verifying and applying the notions of mineralogy and geology taught in class. He also liked the cataloging activities and felt satisfied upon completing the datasheets correctly. Furthermore, he was surprised to find out that the school he was attending preserved samples so historically and scientifically relevant, which need to be preserved and known not only by the school population but also by scholars and the general public. These findings met the goals of the recontextualization of science education [170] listed by Gericke et al. [171] (p. 245) in their systematic review of scientific laboratory works in secondary schools. Quoting Hodson [172,173], the authors identified three main learning aims: learning science (i.e., understanding the concepts, models, and theory of science), learning about science (i.e., understanding how scientific knowledge is developed), learning to conduct scientific research (i.e., acquiring skills and knowledge for practicing scientific inquiries), addressing socio-scientific issues (i.e., developing critical skills to investigate social, economic, and moral–ethical aspects of science). The cataloging activities indeed helped the student to develop a better understanding of mineralogy and geology, acquire skills in gathering information from the observation and handling of rocks and minerals, and gain experience in

compiling the BNM and BNPE cataloging datasheets according to different kinds and levels of knowledge, while questioning the nature of conservation of natural specimens in school museums and raising community awareness on their proper preservation and valorization.

During the round table, teachers supported the laboratory activities performed using the historical geo-mineralogical collections kept at the Istituto San Giuseppe Calasanzio as a complementary resource to the classroom lessons, which helped develop interdisciplinary didactic proposals. They also appreciated how the laboratory work was carried out, underlining that the student-made cataloging of school museum collections is a powerful tool to stimulate their critical thinking skills. Findings similar to those listed above were also reported by Caironi [174] in her report on laboratory activities using minerals and rocks to enhance earth sciences literacy in Italian secondary schools.

Both students and teachers agreed that cataloging natural history collections with ICCD national standards represented an effective tool to safeguard, preserve, and valorize the Italian scientific school heritage by publishing the catalog records in OA on the CGBC database.

Browsing the CGBC database by keywords, it is found that the term «school» (scuola) retrieved 675 catalographic records. Among these, 60 records concern the cataloging of the rock collection kept in the Istituto Tecnico Industriale Michelangelo Buonarroti, a secondary school in Caserta [175]. The remaining records are related to university museums such as the Museo di Anatomia Patologica e Paleopatologia of the University of Pisa [176], which cataloged 387 morbid anatomy specimens using the AT national standard.

Searching the CGBC natural heritage database for «school institute» (istituto scolastico), 1078 records are retrieved, most related to herbals whose folia were cataloged using the BNB national standard. The most interesting aspect of this finding is that the herbals were part of school teaching collections such as the Istituto Magistrale "Isabella Gonzaga," a secondary school for training primary teachers in Chieti. The natural history collections—also comprising taxidermized specimens, wood samples, fruit, and mushroom models—are now preserved at the Museo Universitario of the University of Chieti together with the scientific instruments coming from the laboratories of both the Istituto Magistrale "Isabella Gonzaga" and the Liceo Classico "G.B. Vico" [177]. For the remaining herbals, 502 catalog records belong to the Istituto di Istruzione Secondaria Superiore "G.B. Cerletti" of Conegliano, in the province of Treviso. In this regard, it is interesting to note that the cataloged volumes are still preserved in the school.

The keyword «high school» (liceo) returned 125 catalog records, the majority of which are represented by zoological specimens (ca. 115 samples) that were part of the natural history teaching collections of the Liceo Classico "G.B. Vico" in Chieti and therefore are now housed at the Museo Universitario.

This survey suggested that cataloging natural history teaching collections using the ICCD national standard for natural heritage is an effective tool for safeguarding, preserving, and valorizing school heritage. In this regard, the cataloging campaign at the Istituto San Giuseppe Calasanzio added 187 cataloging records regarding mineralogical specimens and 13 cataloging records concerning rock samples to the CGBC database.

6. Conclusions

The present research aimed to recover, preserve, and valorize the 18th century geo-mineralogical collection belonging to the Mineralogical Cabinet of the Collegio Nazareno and now housed at the Istituto San Giuseppe Calasanzio of Rome.

This study has identified 1724 specimens at risk of loss and damage, including 59 samples from the Holy Roman Emperor Joseph's II collection donated to the Mineralogical Cabinet in 1785. The latter was one of the most significant findings from this study since no other mineralogical collections can be currently credited to Joseph II.

All the recovered specimens were inventoried in an offline database providing scientific, historical, and technical information retrieved by studying the specimens and the archival material (e.g., inventories, catalogs, and display labels). About 100 specimens

were treated with basic remedial conservation remedies. A catalog campaign concerning 200 specimens was performed using the ICCD national standards for cataloging minerals (BNM) and rocks (BNPE). The results of this operation showed that as occurred in other fields of science education and museum studies [178,179], the geo-mineralogical specimens can be positively used as scientific–educational tools in object-based learning experiences and cross-cultural student activities to promote science literacy

Overall, this study strengthens the idea that cataloging natural history school collections, especially those kept in private and religious institutes, using the seven ICCD national standards for the cataloging of natural heritage (e.g., BNM, BNPE, BNPL, BNP, BNZ, BNB, and AT) is a valuable tool for tracing, recovering, preserving, and valorizing these unique nature-objects.

Fourth- and fifth-grade secondary school students were involved in arranging the new permanent exhibition on the institute's ground floor. This activity represented a unique learning opportunity for students and teachers, especially regarding the rediscovery and knowledge of the local school heritage and its impact inside and outside the school community.

The analysis of cataloging activities in PCTO plans showed that laboratory work using school museum collections improves students' observational and reasoning skills. They also represent valuable tools for enhancing scientific literacy [180] and developing interdisciplinary proposals even in traditional classroom lessons. The case study discussed in this study showed that, when recovered and made newly accessible to teachers and students, natural history school collections become valuable tools for transdisciplinary practical learning.

In conclusion, as suggested by Brunelli [181], cataloging campaigns involving students when teaching collections are present should be encouraged and related to the curricular activities to improve the knowledge of school heritage, promote science learning, and help teachers, educators, and museum operators to safeguard and make accessible these collections to anyone interested in learning more about the history of science education.

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