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# The Mining History of Greece in School Textbooks: The Case of Lignite †

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**Abstract:** The geological education in Greece is essentially rooted in the second half of the 19th century, since 1836, when secondary education was established in Greece. Although geology is referred to in all educational programs, its field was not taught before 1880, due to the lack of competent teachers and suitable books. Geological education in Greece was established as a "necessary" science at the end of the above century, during Greece's opening phase of mining activity. In particular, the first attempt to exploit lignite deposits began in Aliveri (Evia) in 1873, but the intensive exploitation in Aliveri began after the First World War, reaching an annual production of 23,000 tons by the end of 1927. Respectively, lignite mining began in Ptolemais in the 1950s and Megalopolis in the 1960s. In the present paper, the correlation of the lignite mining activity in Greece for electricity generation with the content of geoscience textbooks is investigated since it is widely accepted that education is directly linked to economic development.

**Keywords:** secondary education; geological textbooks; lignite mining



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## 1. Introduction

Geosciences play a crucial role in developing holistic systems thinking, involving the consideration of major Earth systems, such as the water and carbon cycles [1].

In recent years, a significant development in geoscience's education is enhancing the searching and analyzing of information given in school textbooks. In particular, the above methodology was implemented in the study "The historical development of geological education in Greece" [2]. In this study, among other elements, the number of pages of scientific content of geology and mineralogy, scientific figures, and descriptive figures are counted in a total of 127 school textbooks from 1830 to 2010. Additionally, Chiappetta and Fillman [3] analyzed five biology school textbooks from 2002 to 2004 to determine the magnitude of emphasis given to knowledge and its interactions with technology and society. In addition, an attempt was made to ascertain whether the present books of biology have a different distribution and proportion of their subjects than those written in previous years. Park (2005) [4] developed a methodology to investigate the differences between a standard school program in the U.S.A. (EarthComm) and curricula that follow traditional books. To substantiate his point of view, the author chose to compare the laboratory activities contained in three textbooks.

The main research question refers to the degree to which knowledge regarding extraction and use of lignite is reflected in the geoscientific textbooks during 1900–2010. School textbooks often reflect the social and economic needs of a country [5]. In this framework,

the method of content analysis of the Greek textbooks is applied. The proposed survey includes a measurement procedure for counting the occurrence of mining terms related to lignite in the school textbooks of the Greek modern educational system [6,7]. The statistical analysis is also based on the distinguishing of specific periods regarding lignite mining in Greece.

Furthermore, the main characteristics of each period are discussed. The study of the curriculum and the textbooks revealed that they correspond to the social dimensions and characteristics. In this context, it could provide a helpful tool for examining related issues.

## 2. Materials and Methods

### *2.1. Study Data*

The first lignite mine operation started in **1833** in the **Kymi (Evia) area**, attempting to use the lignite in the shipyard ovens and the boilers of the first steamboats. However, organized mining started there almost forty years later, when in **1873**, several individuals were granted rights from the state to excavate lignite.

The first underground lignite mine in the **Aliveri (Evia) area** started operation by the private sector in **1896**. However, one year later, it was shut down when the tunnels were flooded with sea water.

With the start of World War I in **1914**, new exploitation was attempted. However, it was a cursory and rapacious mining operation that caused significant destruction to the deposit.

In **1918**, the incorporation of the Societe Anonyme of Aliveri Coal Mines, better known as the Aliveri Company, acquired the rights to mine the deposit. The lignite production in the Aliveri mine that year was **12,849** tons.

In **1927** the company's financial collapse started, resulting in the company's dissolution and liquidation in 1934. However, the company continued to operate the mines under the management of the liquidators, and **1949** was the first year when an increase in production was achieved, reaching **25,000** tons annually, accompanied by an improvement in the mining methods.

A new chapter for the Aliveri coal mine started **in 1950**. In early autumn, it was expropriated in favor of the Greek state, subsequently, as of 1 November 1951, favouring the newly established Public Power Corporation (PPC), thus forming the source for the PPS's first thermoelectric power plan (TPP). On 9 November **1950**, a contract was signed between the Greek state and Pierce Management Inc., a specialized U.S. company that would act as the primary subcontractor to the PPC. By that time, PPC had taken over the titanic project of the electrification of the whole country, which the wars had destroyed [8]. The contract included completing the mechanical installations, the winch and the elevator, the excavation operations on the surface, the excavation of new wells, the construction of main entries and inclines, and all the safety mechanisms required for an underground mine. Between 1951 and 1988, 18.60 Mt of lignite were produced from the Aliveri mine, mainly by underground mining.

Figure 1 illustrates the annual lignite production of PPC mines for the period 1959–2019, and Figure 2 shows the electricity generation by source in the interconnected system of Greece between 1961 and 2020.

To investigate the correlation of the lignite mining activity in Greece for electricity generation with the content of geoscience textbooks, a representative sample of the textbooks was selected to cover the whole range of study periods. The sample comprises thirty-five (35) textbooks used in secondary education from 1845 to 2020 for geosciences.

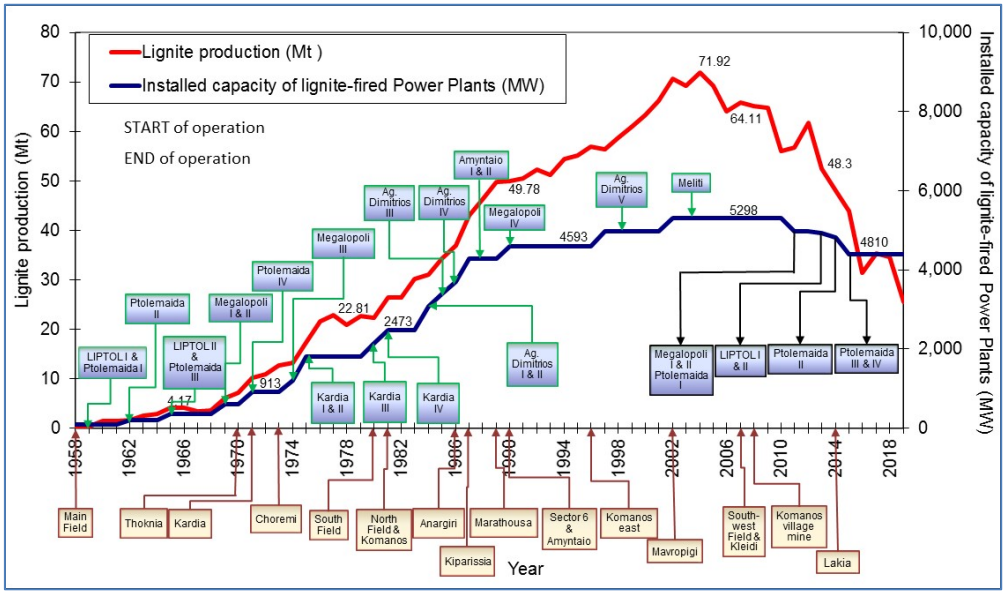


**Figure 1.** Lignite production (Mt) of PPC mines and the installed capacity of lignite-fired power plants (MW) (1959–2019).

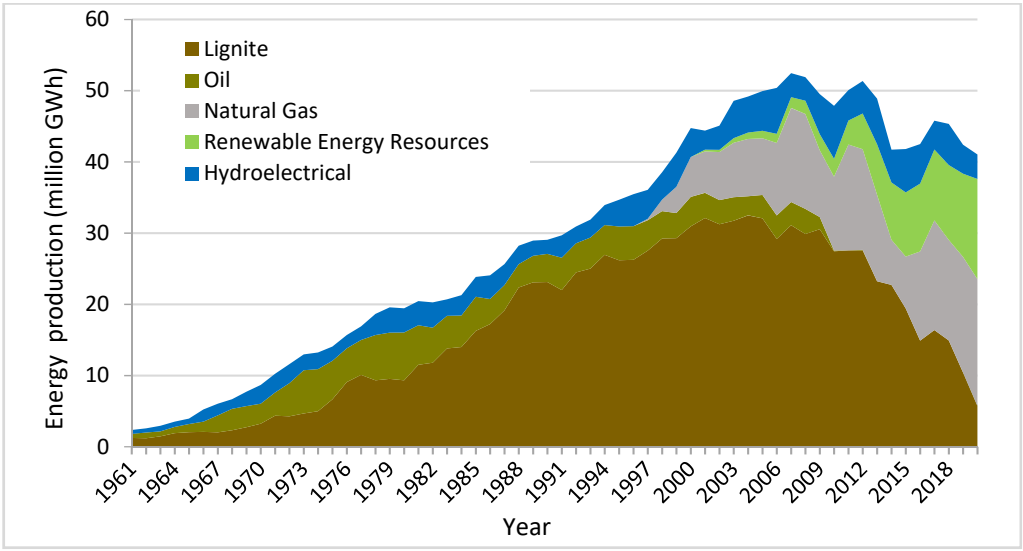


**Figure 2.** Electricity generation by source (GWh) in the interconnected system of Greece (1961–2020).

### *2.2. Methodology*

In the framework of the present study, the method of content analysis of the Greek schoolbooks was used. Content analysis is a methodology that enables researchers to study human behavior through the analysis of their communication. It is based on analyzing all kinds of communication forms, such as textbooks, essays, newspapers, novels, magazine articles, cookbooks, songs, political speeches, advertisements, and pictures [9]. Ben-zvi-Azarf and Orion (2005) [10] presented the methodology of content analysis thoroughly.

The analysis of people's communication can reveal conscious and unconscious beliefs, attitudes, and values at a personal or group level. Content analysis is often used in conjunction with other methodologies, particularly educational research, where it can be used to code, categorize, and quantify data.

The methodology for capturing the context, which describes the content of lignite mining in school textbooks, was developed as follows.

For the quantification of lignite mining content, the following criteria were used:

I. Content of lignite mining, i.e., % pages of content in the relevant section of the textbook.

II. Characterization of the scientific adequacy of the content graded **I** to **III** (**poor, satisfactory, and excellent**). The analysis of textbooks was divided into the following periods according to the time evolution of lignite production and construction of power plants (PP) units, as it is presented in Table 1.

**Table 1.** Characterization of period analysis.

| Period | Years | Characterization of Mining Capacity | Characterization of Content Lignite Mining in Textbooks |
|---|---|---|---|
| **1** | Before 1917 | I | I |
| **2** | 1917–1950 | I | I |
| **3** | 1950–1970 | I | II |
| **4** | 1970–1990 | II | II |
| **5** | 1990–2010 | III | I |
| **6** | 2010–2020 | II | I |

## 3. Results and Discussion

The presentation of the periods and their characterization concerning "Characterization of mining capacity" and "Characterization of content lignite mining in textbooks" are presented in Table 1. The time separation of the periods follows the time evolution of lignite mining and use in Greece, as described in Section 2.

Significant differences are observed in terms of the quality content of the textbooks for lignite mining and use. More specifically, insufficient references are observed in the textbooks, while they emphasize the use of lignite in religious relics during the 1st period of study (before 1917). In the 2nd period (1917–1950), the geographical areas of Greece, where lignite mining took place, are mentioned for the first time, such as Aliveri, Kymi, Korinthos, Oropos. Lignite mining involves its use for fuel, field fertilization, and as a pigment. However, the content of the textbooks remains merely geographical and descriptive, without any scientific approach to lignite mining during periods 1 and 2. The first scientific approaches to lignite mining appeared in school textbooks in the period 1945–1950.

In the 3rd period (1950–1970), the quality content is upgraded; the textbooks' scientific content is referred to the potential of lignite mining in many areas, such as Ptolemais and Megalopolis. More specifically, the textbooks contain informative data regarding the annual lignite production for each mining area, the annual produced energy from lignite, as well as the estimated lignite mining capacity per area (Figures 1 and 2). The scientific content of the 4th period remains at the same level. However, several pictures and photos from the mines are incorporated, following technological advances and making the textbooks more attractive.

After the 1990s (5th and 6th period), the references to lignite mining and use are significantly degraded, and, at the same time, the content on renewable energy sources is gradually strengthened.

By comparing the mining history with the textbooks' content, an increase in the percentage of mining content in the 3rd and 4th periods is noticed. An increase in lignite exploitation in the 4th and 5th periods follows. The 5th period marks the significant reduction in lignite content in the textbooks, followed by the gradual reduction of the lignite mining activity.

The percentage content of mineralogy and lignite in the geosciences textbooks are presented in Figure 3. The mineralogy's quantitative content is highly increased during periods 2 and 3, followed by a significant decrease for periods 4 and 5.

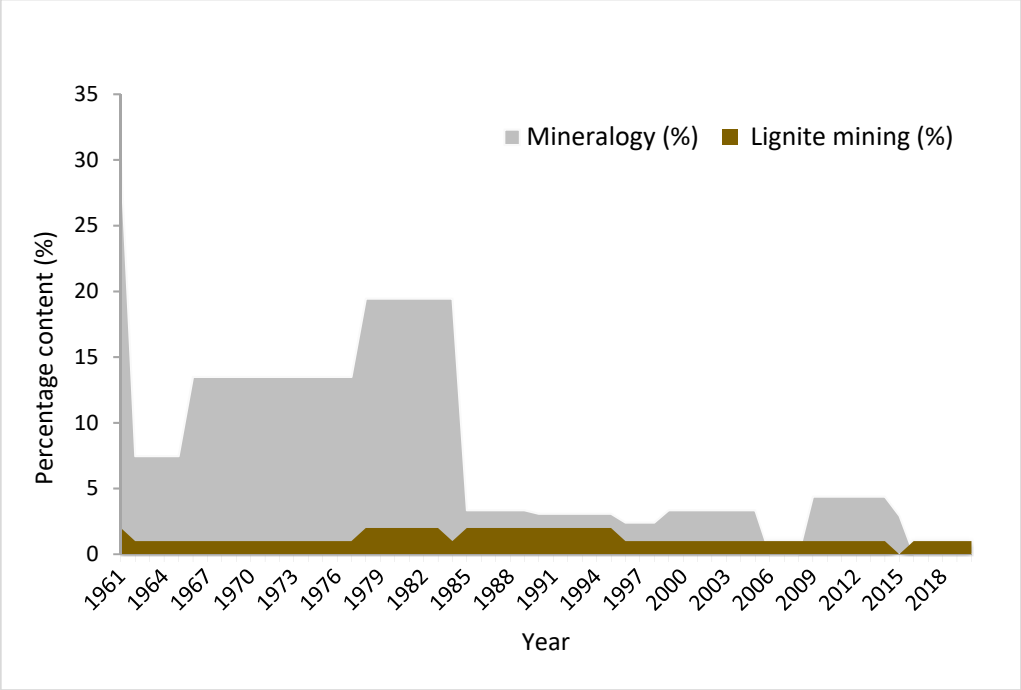


**Figure 3.** Content (%) of mineralogy and lignite mining in the geosciences textbooks.

Throughout the study period, the quantitative content in the textbooks of geosciences on the mining and use of lignite is very low. The percentage of the corresponding pages to the total pages of the textbook is about 1% for most years of the study period, and only for periods 3 and 4 (1950–1990), there is a slight increase to 2%. It is noteworthy that there is no reference on the energy use of lignite, except for the textbook in 1942, where the first descriptive reference is found. On the contrary, after the 1990s, the presence of scientific knowledge regarding lignite mining is significantly reduced, with explicit references to renewable energy sources.

The matrix plot of Figure 4 displays the pairwise relationship of the percentage of the electricity produced by lignite in the interconnected system, the percentage of the mineralogy content and the percentage of the lignite mining content in the geosciences textbooks.

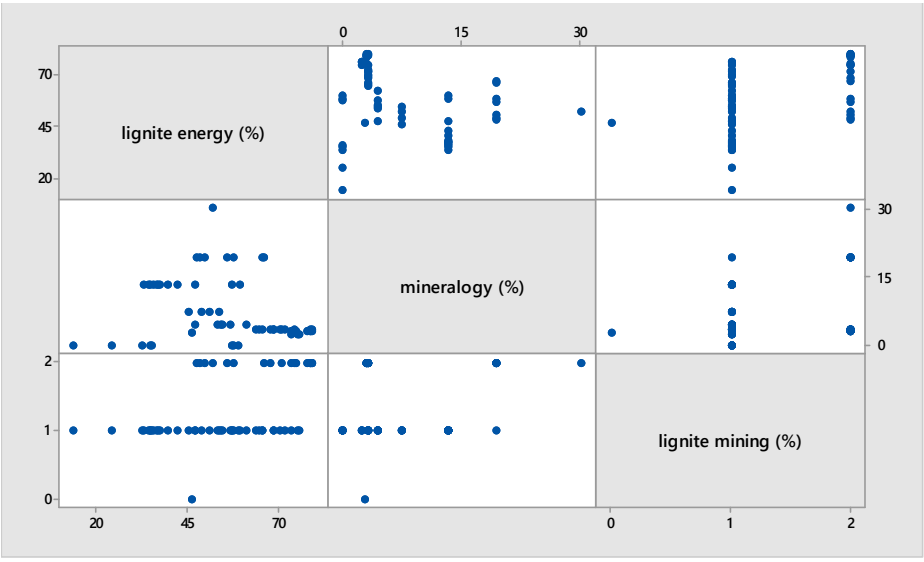


**Figure 4.** Matrix plot of electricity generated by lignite (%) in the interconnected system, the content of mineralogy (%) and content of lignite mining (%) in the geosciences textbooks.

Based on the corresponding correlation analysis, the lignite mining content (%) presents a moderate positive linear (Pearson correlation 0.463 with $p$-value = 0.000) and monotonic (Spearman rho 0.485 with $p$-value = 0.000) relationship with the contribution of lignite in the electricity generation (%) in the interconnected system. On the other hand, the correlation of mineralogy (%) content with the lignite mining content (%) is a weak positive linear (Pearson correlation 0.251 with $p$-value = 0.053) and monotonic (Spearman rho 0.155 with $p$-value = 0.237). Finally, the content of mineralogy (%) presents a weak negative linear (Pearson correlation −0.253 with $p$-value = 0.051) and non-monotonic (Spearman rho −0.283 with $p$-value = 0.028) relationship with the electricity produced by lignite (%).

## 4. Conclusions

From the comparative evaluation of the quantitative and qualitative content of textbooks concerning lignite mining, it is concluded that there is a particularly low content in textbooks, even during Greece's electrification and the maximization of lignite utilization in the country's energy mix. However, considering the evolution in electricity generation and energy transformation, the scientific knowledge regarding lignite in the textbooks is related to the long-term energy trends. The research is at an early stage and the first attempt at this kind of analysis in Greece and Europe.

Proposed future research may refer to relevant studies considering the textbooks of other countries. It could also include the relationship of textbook authors to the PPC, which mainly exploits the lignite deposits in Greece, investigating whether the authors had a scientific and professional relevance to PPC and whether this affects the content of the textbooks. The research could also be extended using the Greek chemistry textbooks since their content can also be related to coal and lignite over time.

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## References

1. King, C. Geoscience education: An overview. *Stud. Sci. Educ.* **2008**, *44*, 187–222. [CrossRef]
2. Makri, K. The Historical Development of Geological Education in Greece. Ph.D. Thesis, Department of Geology, Aristotle University of Thessaloniki, Thessaloniki, Greece, 2015.
3. Chiappetta, E.L.; Fillman, D.A. Analysis of Five High School Biology Textbooks Used in the United States for Inclusion of the Nature of Science. *Int. J. Sci. Educ.* **2007**, *29*, 1847–1868. [CrossRef]
4. Park, D.-Y. Differences Between a Standards-Based Curriculum and Traditional Textbooks in High School Earth Science. *J. Geosci. Educ.* **2005**, *53*, 540–547. [CrossRef]
5. Matthews, M.R. *Science Teaching: The Role of History and Philosophy of Science*; Routledge: New York, NY, USA, 1994.
6. Makri, K.; Pavlides, S.B. The Evolution of the Content of Geology Textbooks in Greece at 19th–20th Century. In Proceedings of the Conference ESERA 2013, Nicosia, Cyprus, 2–7 September 2013.
7. Makri, K.; Pavlides, S.B. Classification of Contents of Geosciense in Secondary Curricula in Greece, 1830–2015. *Bull. Geol. Soc. Greece* **2016**, *50*, 238–244. [CrossRef]
8. Roumpos, C.; Pavloudakis, F.; Liakoura, A.; Nalmpanti, D.; Arampatzis, K. Utilisation of Lignite Resources within the Context of a Changing Electricity Generation Mix. In Proceedings of the 10th Jubilee International Brown Coal Mining Congress, Bełchatów, Poland, 16–18 April 2018; pp. 355–365.

9. Fraenkel, J.R.; Wallen, N.E. *How to Design and Evaluate Research in Education*, 7th ed.; McGraw-Hill: New York, NY, USA, 2009; ISBN 978-0-07-352596-9.
10. Ben-zvi-Assarf, O.; Orion, N. A Study of Junior High Students' Perceptions of the Water Cycle. *J. Geosci. Educ.* **2005**, *53*, 366–373. [CrossRef]