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The Role of Mineral Raw Materials Education in a Social License to Operate—A Case of Poland

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Abstract: The Social License to Operate (SLO), understood as the consent of a wide group of stakeholders to mining activities, has become an important element in the process of obtaining a mining license in recent years. Such a pattern of increasing importance is common, both in Poland and throughout the EU. Therefore, it should be of key importance to prevent society's reluctance to this industry. The article indicates that a very important tool in this matter should be reliable and knowledge-based raw materials education, carried out as early as at the stage of school education. Deficiencies in this respect were revealed through a survey conducted among children and youth up to 15 years of age. The results of the survey were discussed in the context of the development of raw materials education in Poland, which results indicate should focus on emphasizing the benefits of mining, both in terms of the general public and individuals. Shaping and strengthening the mineral raw materials awareness of the inhabitants of Poland is also of key importance for the implementation of standards for the protection of mineral deposits and ensuring the country's resource security.

Keywords: SLO; raw materials education; raw materials security; awareness; Poland

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1. Introduction

The role of the exploration and exploitation of mineral deposits in meeting the basic needs of human life and social development has been undeniable for centuries and has been repeatedly emphasized in scientific works and analytical documents [1–5]. The naming of many historical stages of civilization (e.g., the Stone Age, Copper Age, Bronze Age, and Iron Age) shows that natural resources of various kinds were absolutely fundamental to human development. Even today, sectors such as construction, chemicals, automotive, aerospace, electronics, power generation, and machinery manufacture are completely dependent on access to many minerals. At the same time, these industries provide products that meet the needs of society and individuals and ensure the economic development and security of a country. It is estimated that the consumption of minerals used for energy, transportation and construction infrastructure, as well as consumer goods of modern societies has grown at an average rate of 2–5% per year over the past century [6]. Currently, each person in the EU consumes an average of several tons of minerals each year [7]. In Canada, the volume exceeds 20 tons, and in the US it is almost 19 tons [8].

The improvement of human welfare has invariably been accompanied not only by an increase in the demand for mineral resources, but also by an increasing variety of materials used. Projections indicate that by 2050, global metal mining and biomass production will need to have increased by at least 50% and non-metallic mineral production by at least 100% [9,10]. The Organisation for Economic Co-operation and Development (OECD), in turn, forecasts doubling of mineral consumption over the next 40 years–from 89 Gt in 2017 to 167 Gt in 2060 [11], mostly due to developing countries where several billion people will move from the low to medium consumption level. As societies become more complex, the ways in which they use mineral resources become more complex [12]. New materials are being developed–used, for example, in modern electronics and renewable

energy technologies–for the production of which sometimes rare metals are used [13] and for which it is difficult to find a substitute. An extremely important driving force of growth in demand for mineral resources will be, for example, the energy transition that EU countries are facing. While it assumes a shift away from fossil minerals, it will drive the use of many metallic mineral raw materials (e.g., lithium, cobalt, graphite, and REE) on an unprecedented scale [5,14].

At the same time, the era of rich and easily accessible deposits is coming to an end. As a result, mining companies often face the challenge of undertaking mining operations in complicated environmental conditions and often in the absence of support from the public and local authorities. In mining operations, it is not the mere availability of raw material with specific resources and expected quality that is becoming increasingly important, but the Social License to Operate (SLO) [15]. Across the EU, the level of acceptance of mining industry is still significantly lower compared to other sectors of industry [2].

SLO is not legally standardized in any way, yet it is becoming a key element for mining operations. It is nothing but informal and voluntary consent and acceptance of an activity expressed in the absence of opposition from the local community, authorities, and other stakeholders [16–19]. This concept began to develop in mining as early as the 1990s [20–22]. The phrase "social license to operate" was first mentioned by an executive of Placer Dome at a 1997 World Bank meeting describing an essential requirement for the future survival of the mining industry [23]. The term was originally used mainly by industries reliant on extractive use of natural resources [24], and is derived from the broader concept of Corporate Social Responsibility (CSR).

The lack of social acceptance for mining activities unquestionably affects the possibility of satisfying the demand of a country's economy for mineral raw materials from primary domestic sources (mineral deposits). Social conflicts are described both in Poland and other EU countries [25,26]. In 2021, gaining public acceptance and meeting local community and stakeholder expectations was rated as the fourth largest risk to the mining industry [27]. This high ranking of SLO in the ranking of risks to the mining industry has persisted for at least 15 years [28]. In the long-term perspective, it may be important for the raw material security of the European Union, whose raw material policy–as per assumptions–should be based on the use of its own (internal) mineral sources in order to maximize its independence from external (import) sources [29,30].

With SLO becoming as important as legally regulated mining licenses, it becomes crucial to answer the question: what are the reasons for the society's aversion to the mining industry? The dominant factor, of course, is the fear of pollution and environmental degradation as well as negative impacts on human health and safety. There is a concern that the new–mining–land use direction will reduce accessibility to existing sources of income (e.g., agriculture or tourism). At the other extreme, there is a rather controversial argument that conflict is common because mining companies have too little respect for human rights and do what is necessary to advance their project, sometimes deliberately generating conflict between communities [31].

A significant factor contributing to the limited confidence in the mining industry, is certainly the relatively low or very low awareness of the importance of the mining industry to people and economic development, even at the local level, which for stakeholders is closest and can directly affect them. Knowledge of how often in everyday life we come into contact with objects that would not have been possible without the exploitation of a given mineral is alarmingly low. Awareness-raising in this topic area should begin as early as the school years, using age-appropriate tools. The starting point for such formulated hypotheses is the results of a survey, conducted by the author, among elementary and secondary school students. The aim of this paper is to present its results in the context of the quality of raw material education in Poland and the possibility of its development on the basis of existing curricula for selected subjects. The work is based on the first survey in Poland, conducted on a large scale, showing the general attitude of children and adolescents to mining.

There are no scholarly works in the national literature on such an issue, especially based on extensive survey research. The international literature also has a shortage of works addressing this topic. Existing ones mainly focus on higher education (e.g., [32]). However, it should be mentioned that raw material education is increasingly emerging as a leading theme in international projects and initiatives such as ENGIE [33] and BRIEFCASE [34]. Both of the above are dedicated to children and adolescents at the school and primary education stage. Significant initiatives in raw material education are also being undertaken by Euromines [35]. Mention should be made of the OpenYourMine educational programme which aimed to enhance the creativity, entrepreneurship and skills of the students of the master's degree programme for the sustainable development of mineral resources in Europe [36]. In Poland, education in mineral resources is provided by the Polish Geological Institute, which conducts the National Geological Survey [37].

2. Materials and Methods

This paper presents the results of the author's survey conducted among children and adolescents in three age categories: <10 years, 10–15 years, and >15 years. The survey was anonymous and contained seven questions, including one multiple choice question number 7 (Figure 1). A total of 905 surveys were obtained, of which over 700 respondents were youth over the age of 10. The youngest age group accounted for 15% of the respondents (Figure 2). Age grouping and question topics were consulted with active geography teachers. The questions allowed for a general characterization of the group of respondents (questions 1–3, 5) and for determination of their attitude towards mining activities (questions 4, 6–7), which was the main objective of the diagnostic research. The keywords in question 7 were selected to represent both positive and negative aspects of mining activities, taking into account a fairly wide age range of respondents. Once the results were compiled, statistical analyses were performed using methods appropriate to the data collected to finally compile and visualize the results. This allowed for the verification of the initial hypothesis.

<table>
<tr><td>1. How old are you?
☐ <10
☐ 10–15
☐ >15</td><td>2. Are mining-related issues discussed during school activities?
☐ Yes – the mining impact on the environment was discussed
☐ Yes – the importance of mining for economic development was discussed
☐ Yes – both the importance of mining and its impact on an environment were discussed
☐ No – mining related topics were not discussed</td></tr>
<tr><td>3. Is there a mine (quarry or underground mine) in your area?
☐ Yes
☐ No
☐ I don't know</td><td>4. Would you want a new mine to be built in your neighborhood?
☐ Yes
☐ No
☐ I don't know</td></tr>
<tr><td>5. Does anyone in your family work in the mine?
☐ Yes
☐ No
☐ I don't know</td><td>6. Do you think that in your everyday life you make any use of what mining is about?
☐ Yes
☐ No
☐ I don't know</td></tr>
<tr><td colspan="2">7. Which words do you associate with mining?
☐ development ☐ taxes and fees
☐ electricity ☐ hard coal
☐ fuels ☐ degradation of landscape
☐ contamination of envioronment ☐ sand and aggregates
☐ carbon dioxide ☐ dust contamination
☐ landfill site ☐ danger
☐ remediation ☐ built raw materials
☐ noise ☐ technology
☐ workplaces ☐ security</td></tr>
</table>

Figure 1. Survey—General perception of mining among children and youth.

Surveys were conducted both in the form of online voting (over 600 surveys were collected this way) and in the traditional form. The goal was to maximize diversity in the age structure of the respondents and to achieve the largest possible sample. Due to the fact that the survey was conducted during a pandemic period (in 2021), electronic questionnaires were predominant. The survey was conducted mainly in primary and secondary schools in four provinces of Poland. Additionally, nearly 200 questionnaires

were obtained from the Coal Mining Museum in Zabrze, Poland. There, respondents were mainly school groups and children with family. The Museum is currently one of the largest and most important tourist and cultural institutions in Poland related to mining heritage. In addition, in the autumn of 2021, more than 70 surveys were collected during the Małopolska Researchers' Night, organized in Krakow as part of the 2021 European Researchers' Night.

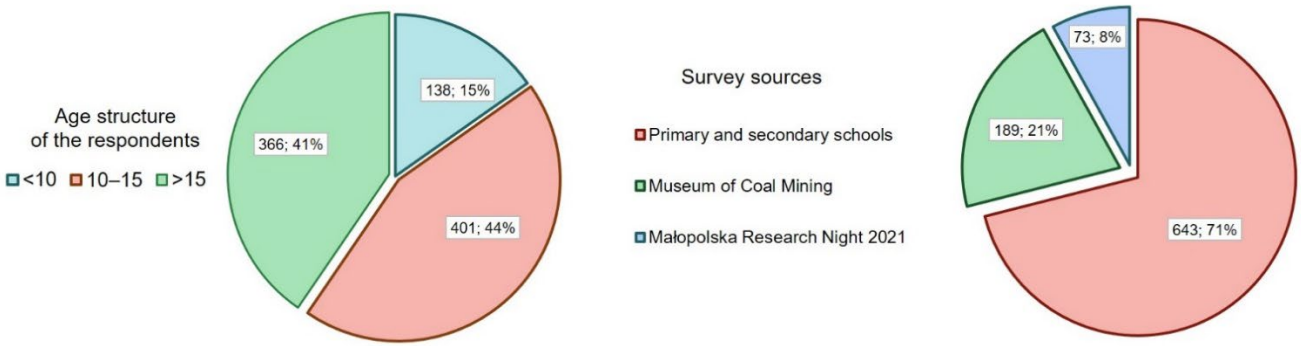

Figure 2. Age structure of the respondents and places where the surveys were obtained.

Moreover, geography curricula, according to Polish primary and secondary education, were analysed in order to evaluate the level of education in the field of mineral resource mining and utilization and possibilities of its modification and development.

3. Results

As mentioned in the Materials and Methods section, the age structure of the respondents was dominated by those over 10 years old. The vast majority declared that there were no mines in the immediate vicinity, or they had no knowledge about them (Figure 3). At the same time, a dominant majority responded that no one in their immediate family worked at a mine (Figure 3). The results indicate that most of the respondents encountered both the importance of mining for economic development and the impact of mining on the environment during their education. However, such responses were prevalent only among students over the age of 15. At the same time–in that age group–more than1/3 of the respondents declared that such topics were not raised at all, or only concerned the negative impact of mining on the environment. In the remaining age groups, this percentage is much higher, and among the youngest it is over 60% (Figure 3).

At least 50% of the respondents reported being aware that they benefit from the mining industry in their daily lives (Figure 4). The most positive responses (70%) were among the oldest survey participants, which may suggest an increased awareness with age as well as new and wider information being conveyed in (mainly) secondary school. This is reflected in the answers to question 2 (Figure 3).

Simultaneously, more than 80% of respondents showed aversion to mines in their immediate vicinity or had no opinion on the issue. This was especially visible among children over 10 years of age (Figure 4).

Moreover, the surveyed group identified mining mainly with hard coal (more than 80% of answers in each group). Other predominant associations of a negative nature were environmental pollution, noise contamination, danger, and carbon dioxide (all >40% of responses) (Figure 5). It is troubling that no more than 20% of respondents (in each age group) identified mining with remediation, technology development, and a source of taxes and fees. Less than 10% of respondents were aware of the relationship between mining and remediation, and between 17 and 42% were aware of the relationship between mining and electricity. It is optimistic, however, that even the youngest were considering mining as a potential workplace (Figure 5).

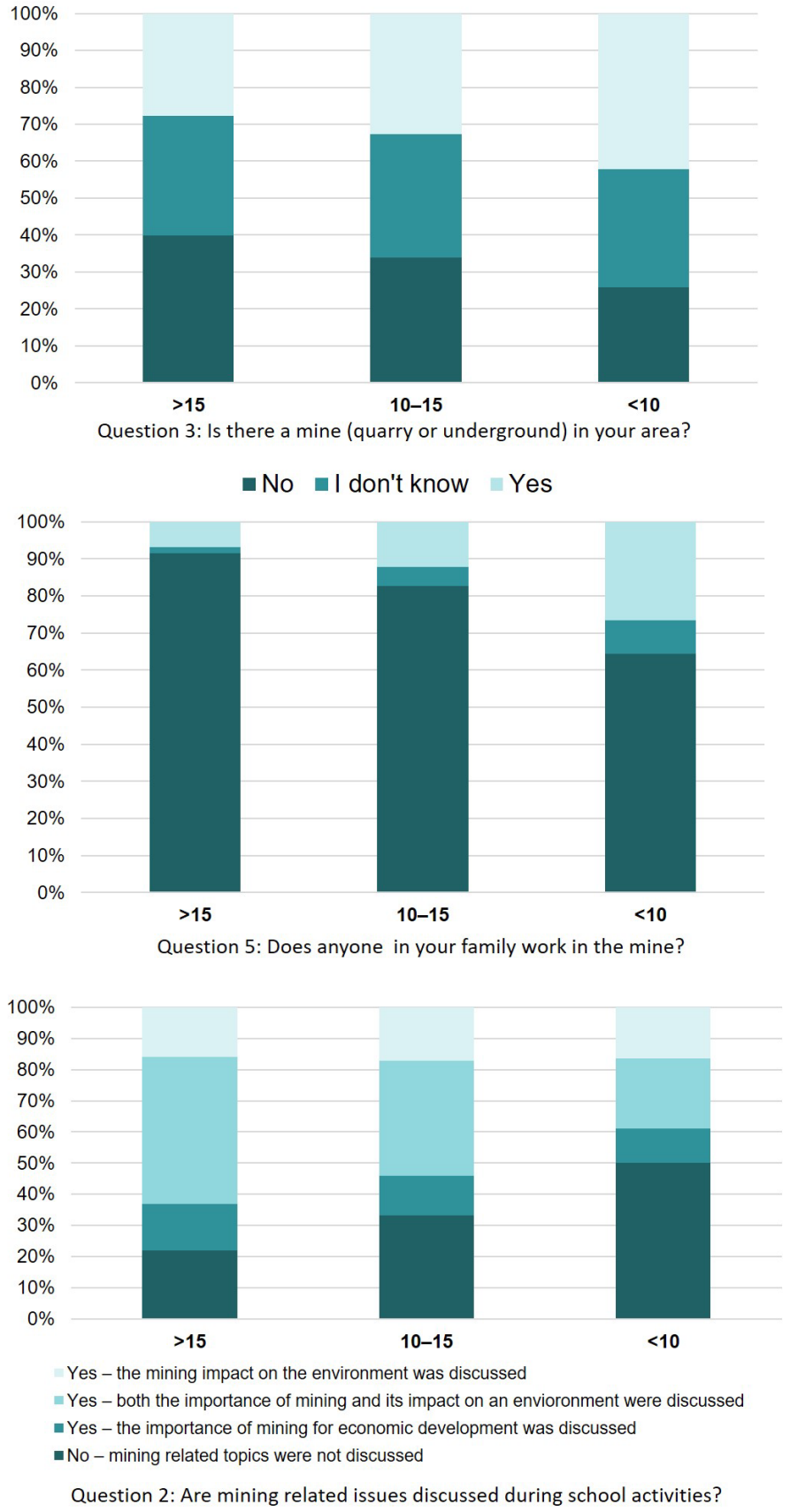

Figure 3. A general characterization of the group of respondents-questions 2–3 and 5 of survey (see Figure 1).

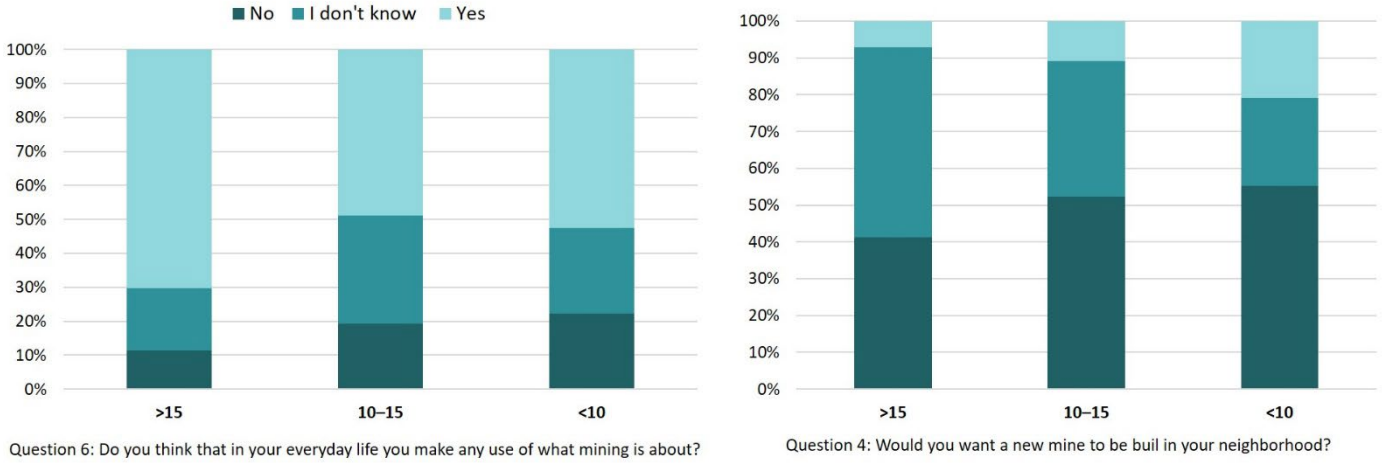

Figure 4. An attitude towards mining activities-questions 6 and 4.

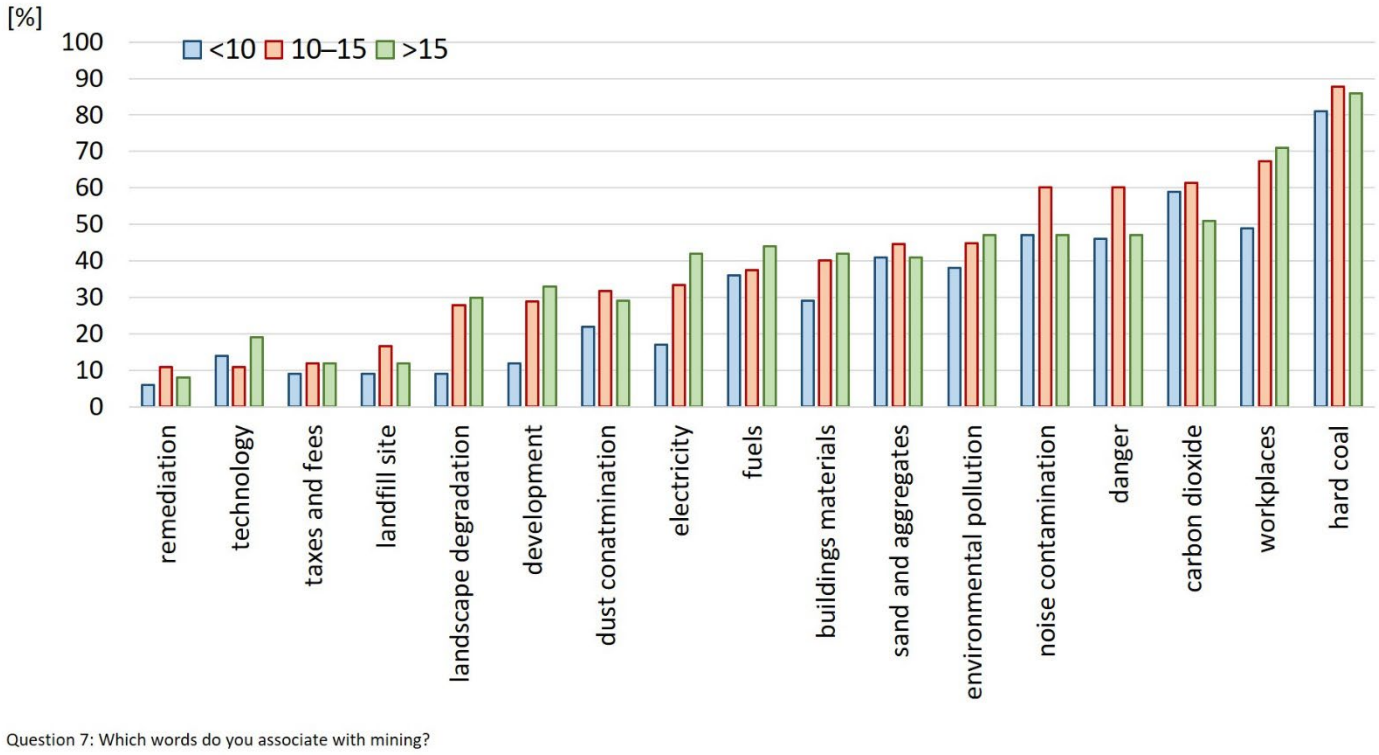

Figure 5. An attitude towards mining activities-comparison chart for each age groups (based on question 7).

4. Discussion

Today's society can be described as a "raw material society" whose prosperity and development, in line with sustainable development goals and global climate policy, are fully dependent on the availability of a variety of mineral resources. Therefore, we can define a mineral and raw material society as a society that fully (at almost all levels of functioning) uses mineral resources in their primary (and more often, processed) form. This is because raw minerals are either used in their original form or are converted into materials and semi-finished products, as well as electricity and heat, for further processing and various other uses. It should be mentioned that these applications accompany every person in everyday life and are the basis for the satisfaction of their fundamental needs. This chain of mineral resources management, with a developing element of partial closure of the raw material cycle (closed-circuit economy), is not known to everyone, however,

and the mining industry evokes mainly negative associations. A significant problem on a national scale is also the identification of the mining industry only with coal mining, which in recent years has been mainly presented in a bad light, and the topic of closing down mines and moving away from the exploitation and use of coal is extremely popular in the media. Strong media coverage could have had an impact on the survey results, especially in terms of question 7. Meanwhile, few citizens are aware of Poland's raw material potential and its importance in the international arena. It is Poland that is the European leader in copper production and the world leader in silver production. It is our country that remains the world's only producer of indigenous sulphur, with decades of mining tradition and being the only producer of coking coal in the EU [38]. Domestic mining also supplies dozens of mineral raw materials to a thriving (broadly defined) construction industry. For years, Poland has also been an important European exporter of minerals or products based on minerals, which makes it an extremely important economic link in Europe [39].

Properly implemented, raw material education should focus on highlighting the aspects and trends listed above. This is because they determine the strength of the Polish mining industry. At the same time, geography is practically the only subject in Poland where reliable and science-based knowledge in this area can be taught. The same is true in other European countries [40]. In Poland, it is a subject present in the education system from the 5th grade of elementary school (children aged 10–11) and continued in secondary schools, of course in varying hourly dimensions. In the 4th grade (children aged 9–10), a subject called "natural science" is the equivalent of geography.

However, mineral raw materials in school education is a marginal topic–both in terms of the quality and amount of information provided. The small amount of knowledge transferred on this topic causes students to forget it very quickly, which was expressed in the survey responses (question 5–Figure 3). Moreover, mining is mostly presented in the context of threats, including environmental threats and threats to human health and safety, which is also reflected in the structure of responses to question 7 of the survey (Figure 5) and is visible responses to in question 4 (attitude to a new mine in the neighborhood). Construction mineral raw materials, industrial minerals, and ores and their economic importance are hardly discussed. Instead, the broadly defined topic of coal and its associated environmental impact, including CO_2 emissions, is dominant (Figure 5). At the same time, people who expressed their approval for the development of this industry in question 4 usually indicated a very broad spectrum of answers in question 7, pointing to both positive and negative associations. Among the positive associations were workplaces, development, and electricity. However, this structure of responses was typical only for the oldest age group. It should also be emphasized that out of 100 (only 9% of all responses) people who did not oppose a new mine in the neighborhood, as many as 75% showed awareness that in their everyday life they use things that were created thanks to the mining industry. Further, out of the above-mentioned 100 people, 70% answered that the subject of the impact and economic importance of mining was discussed during the lessons. The remaining 30% were mainly children under the age of 10. In this case, the curriculum does not provide any content related to mineral resources. This is an optimistic statement, although the number of 100 out of over 900 polls seems small. However, this result means that expanding the knowledge about the importance of mineral resources in the everyday life of every human being may affect the perception of the industry, and in a further step also of SLO. Moreover, many respondents lacked knowledge about the existence of mines in the immediate vicinity (Figure 3–question 2). This is in contrast to the goals set for geography (or natural science in the younger grades) education in Poland, which–according to the assumptions–should strive to teach about one's own region and the immediate vicinity, the so-called "little homeland" [41]. Acquiring geographical knowledge about one's own region and bringing geographical cognition to the "here and now", gives education a concrete dimension that can be easily translated into practical activities in the student's daily life [42]. This approach is clearly lacking in the context of raw material education.

The scope of the core curriculum for the subject of geography [43,44] provides many opportunities in the context of the implementation of correct raw material education, both in primary and secondary schools. At the same time, the educational value of geography as a school subject comes from integrating the student's knowledge of the natural environment with socio-economic knowledge [45]. This approach should be the foundation of mineral resources education. At the same time, this knowledge does not have to be condensed into a single thematic block, but should be divided according to the proposed educational content. The place for it in elementary school (of course in different forms) should be found in such thematic blocks as: maps of Poland, the Polish landscape, geography of Europe, natural environment of Poland, and society and economy of Poland against the background of Europe, but also the relationship between the elements of the geographical environment illustrated with the example of selected areas of Poland, and my own region and "Little homeland" (nomenclature of sections in accordance with core curriculum approved by the Minister of Science and Education-[43]). This approach would make the raw material component present in the educational process throughout elementary school. Currently (broadly defined), the geography of Poland, including the mining industry, appears only in the 7th grade (age of students–13–14 years). Unfortunately, the textbooks used for geography teaching create a rather negative image of this sector of the economy, additionally listing it (together with the processing of mineral raw materials) among industries having the greatest impact on the pollution of the natural environment.

Raw material issues in secondary school do not appear until the 2nd grade (students aged 16–17), but they have a global dimension and do not relate to the national situation. Polish conditions are discussed only in the 3rd grade, which is also the last grade in which geography is an obligatory subject. This subject appears at the last stage of secondary education only when geography is the subject of the secondary school final exam, or when students attend a class with geography profile. As such, it turns out that in practice there is little opportunity to disseminate knowledge on mineral raw materials to 16–18 year olds.

Regardless of the stage of education, there is a clear disparity between information on the negative and positive effects of mining activities, obviously with the former predominating. Little is said about the strength of the Polish mining industry and its importance on a national scale (e.g., GDP shaping) or in Europe, and especially in the region (taxes, jobs, etc.). The textbooks also lack a clear indication of the importance of mining in everyone's everyday life through the characterization of raw materials and detailed directions of their use in relation to everyday objects. In the context of such low quality of raw materials education in Poland, the minimal number of hours of geography is not without significance. In grades 5–6 and 8 (elementary school) it is only one hour per week, and only in grade 7 do teachers have two hours available. The situation is slightly better in high schools, but only in classes focused on geographic education. Then, there are 2 h allocated per week, and for the final grade students, 3 or 4. Field activities should also be important methods and forms of education in geography. This, unfortunately, is not the case, as evidenced by the author's interviews at the schools where the survey was conducted.

It is also often the case that ideological (usually critical) opinions expressed by teachers increasingly replace necessary scientific and technical facts about raw materials. Additionally, the suggested reference literature for teachers dates back to the early 2000s. In the context of dynamic economic changes, the data and information presented therein are outdated. As such, the lack of proper teaching materials is a significant malady. Although the Polish Geological Survey conducts educational activities and the information it presents is reliable, up-to-date and available to the public, its use in geography teaching is still optional and depends only on teachers' engagement. However, what is needed in this area are systemic, top-down solutions, from education of the teaching staff to changes in core curricula and enforcement of certain contents in textbooks.

Incomplete and outdated knowledge transferred at the educational stage unfortunately translates into attitudes in adult life. The only-negative image of the mining industry conveyed–without any indication of its tangible benefits–results in a reluctance and lack of

acceptance for such activity in Poland. As a result, disapproval of mining development is widespread, placing Poland among countries where SLO is a significant risk for such ventures. Despite the requirement for public consultation at the design stage of projects with particular environmental nuisance [46], social conflicts around planned or ongoing mining projects are not uncommon today. They concern both common–rock minerals and those considered strategic for the national economy [25,47–51]. A common way of showing opposition is through protest actions, which, it is worth noting, are often attended by children and young people. Thus, the question is whether their participation is conscious or whether they become a kind of tool in the hands of adults. Adults, in turn, present them as some kind of victims of planned mining activities. It is a common opinion that one of the fundamental causes of such conflicts is a lack of elementary knowledge and proper education about the role of raw materials for the economy and the individual citizen [50,52].

The role of education on this topic is also emphasized internationally [53]. However, it is difficult to clearly define the state of mineral raw material education in other EU countries due to the scarce literature on the subject matter. Assessment is also not facilitated due to differences in each country's education systems, including the timing of compulsory schooling, which means that educational materials are likely to be different. In addition, there are countries in which the competent ministry of education defines national standards or curricula (e.g., Czech Republic, England, Estonia, Finland, Italy, Hungary, Portugal, Romania and Spain), while in others, individual regions have different standards or there are only general guidelines (e.g., Germany, France and Scotland) [54]. Nevertheless, the common feature is that raw material issues appear mainly in geography teaching and are mainly implemented by geography teachers. Just as in Poland, it is not until the 5th grade that geography is clearly separated from the natural sciences. Optional classes on geology are rare and only apply to secondary education (e.g., in the UK, France, and Portugal).

The conducted survey indicated a relatively low quality of raw material education in Poland. The possibility of conducting it online made it possible to obtain a large and representative group. However, the results of the youngest age group are debatable and sometimes difficult to unambiguously analyze. About 30 questionnaires were obtained in this group which had to be rejected in final analyses, due to their mutually exclusive answers. In the future, abandoning research in this age group, or formulating the questions in a different, more accessible way should be considered. Despite some reservations about the results, it gives a clear signal that raw material education is important from an early age. Its type and quality must be adapted to the age of the recipients. Moreover, in the future, it would be interesting to conduct a similar study among students from the territories of "mining communes", where mining is developed on a large scale, bringing real financial profits to the inhabitants and the commune. This would allow obtaining an image of the perception of this industry among children and youth who have direct, almost tangible contact with it. A comparative analysis with the results obtained so far would be valuable.

5. Conclusions

Low public awareness of the use of mineral resources in daily life and the economy is an everyday phenomenon. As are the common aversion to mining activities and the misleading identification of mining as only coal mining and with only negative consequences in the natural sphere. The existence of pattern of thinking was supported by the results of a survey in which the respondents were youth under the age of 18. Widespread protests blocking the commissioning of many mines across the country are a reflection and consequence of this attitude among the adult population. Such phenomena restrict the development of mining industry in Poland which provides mineral resources necessary to meet the living needs of present and future generations and for the competitive economic development of the country. This will have significant negative consequences in the near future. This is because it will make it necessary for many industries to import mineral raw materials which are necessary to ensure continuity of production. Despite the fact that the

national resource base in many cases is very rich, and resource sufficiency is determined for more than 100 years–this applies mainly to rock materials [39].

School-age youth are at the most appropriate age for being provided with competent and up-to-date knowledge in this area, using subjects (mainly geography) that are compulsory in the primary and secondary school curriculum. One of the key actions to be taken should therefore be the pursuit of a reliable information campaign on the impact of geological and mining activities on the environment, which will be based exclusively on scientific knowledge. It is also important to promote mining activities that do not have a negative impact on the environment and, through legally required reclamation, return the previously occupied areas to nature or society. Quite frequently, these can represent new value in terms of nature and landscape. The tangible benefits of the mining industry on a local, regional, and national scale should be clearly highlighted.

Social consent is the ultimate goal and can be achieved through proper education of society. In mining, this consent is expressed through SLO. It is necessary to conduct extensive educational campaigns on mineral resources knowledge, especially for the youngest generation and especially in an era of widespread digitization. If we want to explain to young people where the basic raw materials that meet their needs come from, we have to show them examples that appeal to their imagination. Shaping and strengthening the resource awareness of the Polish population is also of key importance for the implementation of standards for the protection of mineral deposits. This will contribute to the public's understanding of the decisions made by geological administrations to protect mineral deposits. Such postulates are also included in the National Raw Materials Policy until 2050 [55].

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