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CRITICALITY AND THE ROLE OF EDUCATION IN ACHIEVING THE EUROPEAN GREEN DEAL

Cathryn MacCallum¹, Nikki Corder¹ & Ada Civitani²

Abstract

VECTOR is a Horizon Europe and UKRI funded research project investigating social attitudes, environmental and technical challenges to sourcing minerals for the European Green Deal and how they interact. VECTOR is building on the research findings from a Horizon 2020 Project INFAC, to further expand knowledge and research into the use of minimally invasive geoscientific exploration methods. We are also continuing the journey to determine, understand and address many of the social challenges related to mineral exploration and mining in Europe. One social challenge is how and what information is made available, in what form and how to enable more reliably informed decision making. An important aspect of the research project is the role of education. Specifically, what are the challenges teachers face in teaching about controversial or contentious aspects of climate change and society reaching 'Net Zero'. What pedagogical approaches are currently used and how can teachers' confidence and competence be supported to address issues such as the sourcing of raw materials required to meet carbon net zero? Through the research, educationalists and geoscientists from three EU countries are being engaged through a Participatory Action Learning and Action Research (PALAR) process to answer these questions. In doing so, VECTOR is drawing on the just pedagogies of Global Education and Learning to support both critical enquiry and critical thinking, Global Education and Learning are traditionally associated with global awareness raising of social and environmental injustices including controversial issues such as migration, highlighting the need to explore and understand an issue from a range of perspectives to enable an informed decision to be made. Consequently we are positing that such pedagogies are also applicable to contentious issues linked to the European Green Deal and the question: How should mineral extraction and use, as one of the most contentious global challenges of the European Green Deal, be addressed?

Keywords: *Critical Thinking; Nature of Science; Green Deal; Minerals; Global Citizenship; Pedagogy of Hope.*

¹ Sazani Associates, Darkgate, Carmarthen, Wales, UK.

² New Fairy, Milan Italy / University College Dublin, Ireland.

1. Setting the Scene

The European Green Deal (EGD) is a European Commission strategy aimed at making Europe the first climate-neutral continent, intending to achieve this by 2050 (European Green Deal and Cohesion Policy 2020). It is a roadmap to creating a sustainable economy within the EU while transforming climate and environmental challenges into opportunities. The intention is to

“boost the efficient use of resources through the transition to a clean and circular economy, restore biodiversity and reduce pollution” (European Green Deal, a brief summary, 2021).

Since the Paris climate summit in December 2015, the global carbon production has increased by 4%. The European Green Deal plans, as part of the United Nations 2030 agenda, to reduce the EU’s greenhouse gas emissions to 55% of their 1990 levels (Widuto, 2021, p. 2).

The Sustainable Development Goals (SDGs) were adopted by the United Nations in 2015. They are a plan of action for ‘people, planet and prosperity’. Whilst eradicating global poverty by 2030 remains the number one priority, the 17 SDGs interlink economy, environment and society under the banner of sustainable development. This means the SDGs have an all-encompassing remit affecting all areas of life for all peoples on the planet.



Figure 1 - Sustainable Development Goals.
Source: United Nations, 2015.

The SDGs along with the EGD present strategic frameworks for the transformation of Europe into a climate-neutral continent in the future decades. Both the EGD and the SDGs are seeking to achieve a transition to clean, affordable, renewable energy sources to achieve decarbonisation at the lowest possible cost. Currently, EU industry is responsible for 20% of greenhouse emissions, and only 12% of materials used are from recycled sources. The transition to renewable energy is complex and innovation in technologies is dependent on natural resources and raw materials for their development. Regardless of recycling materials and capping CO2 emissions, there is an increased need for mining (Dyca & Carsjens, 2020). Figure 2 below outlines the mineral consumption required for clean energy technologies, highlighting how an electric car requires six times the mineral resources of a conventional car, and the offshore wind power plant requires nine times the resources of a standard gas plant.

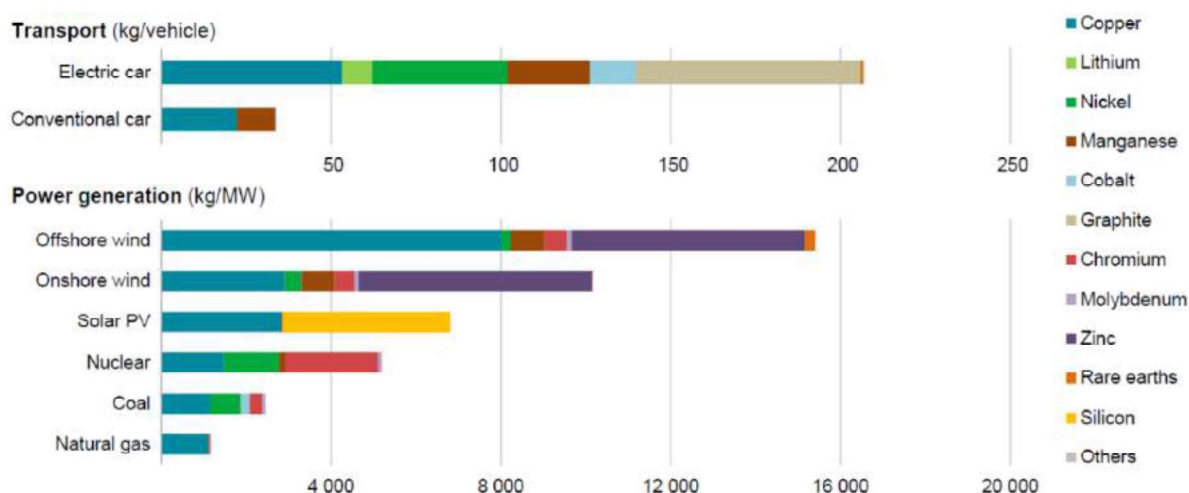


Figure 2 - Mineral consumption per type of green energy.
Source: International Energy Agency, 2021

Furthermore, natural resource demands such as sand, for building concrete and glass, are projected to increase by 45% in the next four decades. This offers environmental challenges when considering the EGD agenda to preserve and restore ecosystems and biodiversity. There is enormous pressure on planetary resources due to increased demand for energy, food and raw materials. This accounts for half the greenhouse emissions and 90% of biodiversity loss (Dyca & Carsjens, 2020).

Access to resources is a strategic question for delivering the EGD. Raw materials are essential to reduce reliance on fossil fuels. By 2020, the EU list of critical raw materials had increased to 30, compared to half that a decade previously. Europe wishes to achieve critical mineral supply security by reducing their demand through increasing the circular economy and diversifying their supply chain. The European Commission (2020) outlines their circular economy action plan towards a cleaner and more competitive Europe. Annual waste is projected to increase by 70% by 2050 and, to reduce carbon and environmental footprints, green technologies are being promoted. Sustainable batteries for digital technologies and vehicles underpin this transition and, although some

of the critical raw materials can be recycled from existing waste, new sources are essential to create sustainable and smart mobility (European Commission, 2020).

Ultimately resources are required in the form of humans and minerals to achieve the EGD's intent, yet resistance to mining projects within Europe appears to present a huge challenge in terms of restricting access to critical raw minerals. How can the EU achieve its decarbonisation aims without addressing its resource requirements and how can such requirements ever be regarded as acceptable? Does critical thinking and deliberative dialogue have a role in resolving this challenge?

The EU's justification of the Green Deal roadmap is tied up with the need to reach net zero carbon emissions by 2050. But how and where do we source the minerals required to get there?

The VECTOR Project, with funding from Horizon Europe and UKRI, which are the primary funding programmes for research and innovation within the European Union and the United Kingdom, builds on research findings from a Horizon 2020 Project INFACCT, to undertake innovative research on how geophysics and data can be used to minimise environmental, social and political disturbance in mineral exploration in three locations in the EU, as well as undertaking a broad investigation of the social challenges related to mineral exploration and mining in Europe.

One social challenge is how and in what form should access to complex information and knowledge that is reliable and factual be made available. This is especially relevant to the controversial or contentious topic of mineral extraction required to achieve the Green Deal. The contentions go beyond the social and environmental impacts of mining, and question how green is the Green Deal? Or alternatively, how can we advance society's technological needs as cleanly as possible? Unpicking these questions and seeking viable solutions is at the core of this debate.

Mineral exploration and mining are increasingly regarded as controversial issues which present both an opportunity and a challenge for the success of the Green Deal. Proctor and MacCallum (2020) write of the importance of dialogic discourse and the need for a critical understanding of any proposed process related to mineral exploration and mining in order to achieve a political settlement. Enabling societal understanding and dialogue should therefore be incorporated into education.

Global Education and Learning, as a pedagogical approach, traditionally focuses on complexity (Romano et al., 2017). Nature of Science similarly establishes the validity and reliability of scientific claims as a core aspect within scientific education (Allchin, 2017). Both present ways for teachers to enable students to interrogate, question and make informed decisions, to confront such complex socio-scientific environmental challenges. This is widely regarded as 'critical thinking' (Solbes et al., 2018). The research is framed by Nature of Science principles (Allchin, 2011) combined with Paulo Freire's "Pedagogy of Hope" (2004), a holistic approach to education that encourages critical thinking, empowerment, and social transformation. Considered together, they encourage collaboration so that understanding and decisions are based on sound scientific principles, open dialogue, ethical considerations, with mutual respect and recognition of differences and commonalities between those who are involved in the debate.

Critical thinking has been shown to challenge prejudice, apathy, indoctrination, and fatalism (Kumar, 2008). Critical theorists, such as Scheunpflug (2020), Olson (2011) Freire (1970), and Giroux (2011), advocate that critical thinking challenges ignorance and complacency, as well as developing critical skills for challenging the abuse of power and associated injustices. In a world where information sits uncomfortably alongside notions of 'mis' and 'dis' information, critical skills are essential in navigating a pathway for understanding complex global challenges, including the responsible sourcing of critical minerals. Ultimately as Freire (1970) in his seminal work on *conscientisation* in Brazil highlighted, to become critically conscious is to be able to challenge oppression and critically interrogate the world.

Through VECTOR, the research is exploring the role of collective ability to address the need for informed and inclusive discussions about sustainable development, environmental protection, and the responsible sourcing and use of critical resources like minerals. All these factors are essential for addressing the pressing challenges of our time. Within this research, the EGD is being framed as a global challenge with spaces for teachers, as global citizens, to engage in discourse about the challenge, to develop critical awareness, consideration and deliberation of the need for critical minerals, and enable consideration of a range of perspectives into alternatives. The debate goes beyond thinking critically about the need for extraction of critical raw materials in order to advance society's technological requirements; it requires systems thinking to consider these complex issues from multiple viewpoints, and subsequent identifying and framing of problems which can adapt to the changing needs within society. The competencies when addressing the global challenges in sustainability have been outlined by the European sustainability competency framework (Bianchi et al., 2022).

2. Establishing a Professional Learning Community

“EU policy on education is designed to support national education and address common challenges” (European Commission, 2023, para. 1). It can be argued that achieving the EGD is a common challenge. Furthermore, the Council of Europe advocates quality education to prepare those who receive education not only for employment, but also for their lives as active citizens in democratic societies, and to ensure their personal development and the development and maintenance of a broad, advanced knowledge base.

Being based on the SDGs framework, the EGD proposed competency framework implies that it should tie in the SDGs that focuses on education and sustainable development, SDG 4.7. This goal states:

By 2030 ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development. (UN, 2015).

Accordingly, Section 2.2.4 of the EGD (2020) states that:

Schools, training institutions and universities are well placed to engage with pupils, parents, and the wider community on the changes needed for a successful transition. The Commission will prepare a European competence framework to help develop and assess knowledge, skills and attitudes on climate change and sustainable development. It will also provide support materials and facilitate the exchange of good practices in EU networks of teacher-training programmes.

VECTOR's focus on education spans the EU, with three communities of practice comprised of teachers, teacher trainers, academics, Global Education and Learning practitioners, and geoscientists from three European states: Ireland, Bulgaria, and Italy, to focus on the role of education and educators in understanding the changes needed for a successful transition to carbon net zero. Together, the communities of practice are sharing and learning from each other through a professional learning community.

Working with teachers and teacher educators, VECTOR is drawing on critical and participatory pedagogies to facilitate a curriculum-linked discussion and informed decision-making process around the Green Deal. In each locality, a community of practice has been established, that will engage in participatory action learning and research, coming together through the professional learning community to share and exchange learning and experiences.

Living with Controversy, a European Council project focussing on teaching controversial issues suggested:

Learning how to engage in dialogue with people whose values are different from one's own and to respect them is central to the democratic process and essential for the protection and strengthening of democracy and fostering a culture of human rights.... Yet in Europe young people do not often have an opportunity to discuss controversial issues in school because they are seen as too challenging to teach (Kerr & Huddleston, 2016, p. 7).

While Living with Controversy focussed predominantly on the rise of xenophobia and civic development in post conflict states, their definition of controversial as 'Issues which arouse strong feelings and divide opinion in communities and society' is relevant to VECTOR and the formal educational component.

In relation to pedagogical approaches, it is equally important to understand the wider, if not global, implications of the EGD, as well as determining societal responses and ability to engage as active and informed citizens.

Much of the work on teaching controversial issues draws on the 'just pedagogies' of Global Education and Global Learning including Human Rights Education, Global Citizenship and Education for Sustainable Development. These are bound by the common understanding of the importance of a critical dialogue to foster and enable informed decision making that incorporates a range of perspectives (Bourn et al., 2017).

Europe has benefitted from a dynamic movement for more than 25 years in advocating for and justifying the importance of Global Learning and Global Education in improving social justice. Global Education and Learning theorists traditionally focus on students and society at large connecting their own identity and sense of place in

the world with the SDGs. Relating learning to a broader social purpose, through a learner centred pedagogical approach, has also been recognised as key to a quality education (Bourn & Hatley, 2022).

Andreotti (2008, 2010) suggests that knowledge is not enough. For education to be effective, it needs to enable students or learners to understand the task of learning “the hows and whys” to critically understand an issue or problem. She has written about the ability to learn through others’ eyes and to unlearn, to be able to understand and enable critical literacy.

Scheunpflug (2004, 2008, 2020) writes about learning and society and the social processes and interconnections related to societal development. She focuses on the challenges of global social justice and the spatial dimensions of social solidarity. Understanding the multiplicity of dimensions and perspectives is key to opening minds and eyes to global and local realities.

Bourn (2008, 2015, 2020) complements both Andreotti and Scheunpflug in his thinking and writing, stressing the importance of the ‘just pedagogies’ as opposed to the ‘adjectival’ educations. By this he refers to the importance of connections between the individual and the personal, the local and the global, enabling learners to look at issues and the world from a different place.

MacCallum (2012, 2022) extends the notion of a just pedagogy to a social and active learning process that can take place in and out of the classroom. Seeing the world through others’ eyes, gaining a range of perspectives on an issue before deciding, interrogating information provided and, ultimately, assuming a critical perspective or attitude, are essential competencies for active and effective citizenship.

The shared inspiration of Freire and his work on dialogic pedagogies, of the oppressed and then of hope, presents a combination of action and reflection on processes, structures and issues that require transformation (2004).

Extending this to debates around access to information across the professional learning community has shown that expert knowledge and information, be it from scientists, policy makers, industry, the media or ‘influencers’, to mention a few, should not be accepted without question. It should be interrogated and deliberated on and scrutinised through a lens of individual and collective experience and relevance, rather than blindly accepted.

Similarly, Allchin (2020) regards Nature of Science as a means to address the complexity of issues and to contextualise these issues in society. He goes on to say that the ability to question scientific knowledge and credibility of the experts, under a lens of social justice, is an essential consideration for civic contention regarding the efficacy of scientific claims.

Such interrogation and deliberation should in turn identify scientific errors, research funding bias and politically competing interests, and challenge the cultural acceptance of scientific claims. This can only be achieved through actively teaching critical thinking skills, and promoting normative dialogue, through a lens of human rights to overcome differences around contentious issues in sustainability debates (Andrew, 2017).

Across the three communities of practice there are different teaching and learning styles and issues regarding how to address or include controversial or contentious issues, such as how and where to source raw materials required for the EGD. Consequently, during the research, the starting point was to agree a starting position, based on existing understanding and curriculum requirements and constraints. This was informed by Fazio (2020), in the UNESCO Ideas LAB, writing on education and the Anthropocene epoch, referring to the fundamental ways humans have changed the planet and how this change to the geophysical and ecological realities also require a change in how we think. He suggests that:

collective and collaborative approaches to education are necessary for citizens to confront complex socio-scientific environmental challenges. Education has the important task of reorienting learners to the environmental realities that we now confront, and realities that we cannot yet forecast (para. 2).

To do this, VECTOR required a research method that encourages active participation, collaboration, and learning within communities. Participatory Action Learning and Action Research (PALAR) is such an approach.

3. Participatory Action Learning and Action Research (PALAR)

PALAR includes collaborative and lifelong learning as tools to perpetuate dynamic social change. It is designed to consider social and contentious issues by first collectively developing a fuller understanding of them from multiple viewpoints and seeking solutions through actively collaborating on research and reflection (Zuber-Skerritt, 2018).

Zuber-Skerritt (2018) identifies essential features of the PALAR process to facilitate this participatory approach. She defines these as the 3 R's and the 7 C's.

The 3 R's of PALAR:

- Relationship – trust, cooperation and team building underpin the PALAR process.
- Reflection – critical reflection on the process, self-reflection on knowledge and co-created knowledge and meta-reflection to develop critical insights.
- Recognition of outcomes, both learning and research to affirm personal and collective outcomes.

The 7 C's of PALAR:

- Communication, cultivated initially through relationship, vision and team-building activities at the very start of a PALAR project or program, to ensure effective research-oriented exchange of ideas and teamwork throughout the project.
- Collaboration among all members of the group, generating team spirit, symmetrical communication, and synergy.
- Commitment to the group, to completion of the project, and to positive, sustainable change and development throughout the project.
- Coaching and learning from one another in dialog, discussion, and by asking fresh questions that open new lines of inquiry (Action Learning).

- Critical and self-critical attitude and reflection on action, which also entails being open to feedback from critical friends and to new or different perspectives (Action Research).
- Competence in facilitating PALAR using effective processes and methods, with a vision of excellence leading to a high level of performance (Action Leadership).
- Character building as a consequence of the above, characterised by integrity, trust (and being trusted), honesty, respect for others, for diversity and for difference, resilience, and an openness to new perspectives, opportunities, and innovations.

The PALAR process takes a cyclical figure of eight models illustrated in Figure 6. At the centre of this model is building and defining the vision. While simultaneously considering context analysis, including a SWOT analysis and constraints, it creates an action plan for practice (Wood, 2017). This continual cycle of practice will incorporate continual evaluation until key outcomes are reached.



Figure 3 - *The PALAR process of design.*
Source: Zuber-Skerritt, 2018.

Methodology

PALAR as a research methodology enables VECTOR to engage and foster collaboration across three respective Communities of Practice (CoPs), engaging them in a participatory and action-oriented approach to explore aspects of the Green Deal and sustainable development. The CoPs are linked through the professional learning communities to engage in shared experiential learning between the three countries.

Ireland had the largest community of practice made up of 21 participants, which include geophysicists, teachers, teacher educators and trainee teachers. Bulgaria is made up of five participants who were all teachers or teacher educators. Italy has four teachers and teacher educators. The Italian community counted on three members, including two secondary school teachers and a teacher trainer specialised in digital learning and school publishing. The professional learning communities enabled the PALAR process to be applied in the three countries independently yet coming together to share and exchange ideas and recognize commonalities and differences between countries. The professional learning communities worked through three cycles to guide the research process, while acknowledging that the shared vision may evolve into differing outcomes within CoPs as part of the PALAR process. This process is outlined in figure 4.

Each CoP has participated in a minimum of three face to face group discussions and one online discussion. The initial meetings enabled the participants to map their personal knowledge, skills, attitudes and values, and through the participatory action process come up with a collective vision. Each cycle of meetings digs deeper into individual and collective knowledge regarding the need for critical raw materials, the impact at an environmental, social and economic level and, ultimately, how to empower teachers to provoke critical thinking around these contentious issues within their teaching paradigm.

A collective meeting of all three CoP's enabled the experiential learning through a participatory action learning activity, which explored the complexity of social, environmental and economic issues to be addressed by a local community when negotiating the potential of mineral extraction in their locality. Teachers agreed that this process was an excellent tool and a possible way to address education for sustainable development across several curricular areas, in addition to promoting the core competencies. However, the implementation of this would vary from country to country according to educational curricula and policy.

GreenComp – the European sustainability competency framework (Bianchi et al., 2022) – was outlined in response to the EU Green Deal and is designed to support teachers in promoting sustainability competencies including critical thinking and systems thinking. There are 12 competencies outlined which fall under four areas: embodying sustainable values, embracing complexity in sustainability, envisioning sustainable futures, and acting for sustainability.

The PALAR process enabled the participants within each CoP to investigate the competencies within the GreenComp framework and identify actions wherein they can be effectively incorporated within their teaching practice. As the VECTOR project is now at the midpoint, the final outcomes are yet to be determined. However, at this stage, there is a concerted agreement of the cyclical process of action research and learning, in which issues and problems are revisited as the complexities unfold in the cooperative investigative process. Within the process, every participant's voice is valued and gives weight to the shared vision of problem framing.

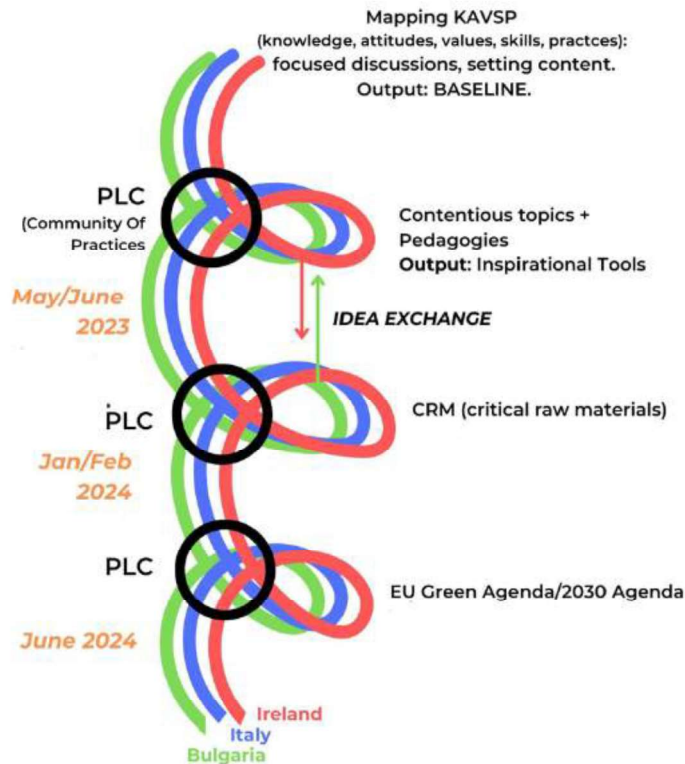


Figure 4 - Professional Learning Community Cycles.
Source: Horizon Europe VECTOR project.

The first cycle of the professional learning community was to establish a baseline. Initially baseline knowledge, attitudes, values, skills, and practices were mapped for each CoP, through focused discussions. Curricula mapping by each CoP enabled commonalities to be identified between counties. The second cycles of the professional learning community focused on pedagogies for contentious issues and included a participatory action learning activity. This activity centred around a fictitious mining project drawing from a range of global mining projects to demonstrate and facilitate a critical enquiry into the complexity of contentious issues from a range of perspectives. It challenged the knowledge, thinking and preconceptions of all participants and provided a roadmap activity to engage students in critical thinking around contentious issues.

The common findings from the professional learning community include the importance of critical thinking skills, the lack of awareness about environmental issues and the EGD, and the need for a more comprehensive understanding of critical raw materials. Additionally, all three CoPs face the challenge of integrating critical thinking into their curriculums, which are traditionally science oriented.

These can be further expanded:

- **Promotion of critical thinking** - All three CoPs emphasize the importance of developing critical thinking skills among teachers and students. They aim to move beyond traditional rote learning and encourage students to explore complex issues and real-world scenarios, fostering a deeper understanding of subject matter.
- **Interdisciplinary learning** - The CoPs advocate for interdisciplinary learning approaches. They encourage the integration of various subjects and perspectives to provide a holistic view of educational topics. This approach helps students connect their learning to real-life situations.
- **Practical application of knowledge** - There is a shared focus on practical application. Whether it's examining the real-world uses of materials (Italy) or addressing global challenges (Bulgaria and Ireland), all three CoPs aim to bridge the gap between theoretical knowledge and practical implications.
- **Engagement of stakeholders** - Each CoP recognizes the value of involving various stakeholders in the educational process. This includes parents, guardians, teachers, student teachers, scientists, and policymakers. Their involvement is seen as essential for providing valuable insights and feedback.
- **Cross-curricular approach** - The Irish CoP specifically highlights the need for a cross-curricular approach to address complex and contentious issues. This approach acknowledges that certain topics, such as sustainability and climate change, cannot be confined to traditional academic disciplines.
- **Innovation in teaching** - All three CoPs promote innovative teaching methodologies. Whether it's through participatory action learning (Italy), involving parents and guardians (Bulgaria), or exploring new curriculum designs (Ireland), there is a shared commitment to improving education through innovative practices.
- **Empowerment of teachers** - Empowering teachers is a common thread. This includes providing them with resources and support, such as knowledge of the EGD (Italy) and involvement in curriculum reforms (Ireland).

In summary, the shared themes include a focus on critical thinking, interdisciplinary learning, practical application of knowledge, stakeholder engagement, innovative teaching, and teacher empowerment in the context of improving education and addressing global challenges.

Two more professional learning community cycles will further investigate critical raw materials and, the process will continue to evolve the thinking within the professional learning community. However, at this stage it is apparent that, despite the evidence within the literature of how vital critical thinking transparent discourse is within ESD and SDGs, delivering critical thinking skills within schools remains a challenge.

4. Concluding Remarks

Critical thinking and inquiry, from a range of perspectives, promotes an understanding of how science works, including its limitations, uncertainties, and the role of evidence. In a multi-country research project, this fosters epistemological awareness among both researchers and stakeholders and will lead to more informed and critical thinking about scientific findings. Emphasising the ethical aspects of scientific research, such as responsible conduct, transparency, and ethical decision-making, and incorporating ethical discussions into research, can help ensure that projects in the EU adhere to high ethical standards. Enabling such discussion and critical inquiry builds teachers competence and confidence as educators to engage their students and learners in a critical dialogue regarding contentious and controversial issues such as mineral requirements for the EGD.

The challenges surrounding achieving the EU's decarbonisation goals, meeting the increasing demand for critical raw materials, mining practices in Europe (including concerns related to the environment, communities, and sustainability), require thoughtful and informed decision-making. Critical thinking can be leveraged to address a number of key issues. It encourages a thorough examination of the trade-offs involved in achieving policy goals. This may include the production, consumption and redistribution of wealth within the EU (Meads & Allio, 2020). Critical thinking enables a focus on systemic interconnections, facilitating the search for solutions and the identification of virtuous paths for achieving objectives. In this way, critical thinking helps to overcome stereotypes and prejudices (that end up polarising the debate without allowing any progress) and shifting attention from "yes/no" a priori, to "why" and "how" in view to act responsibly, which is the sense of citizenship.

There is further scope for research in examining the relationship between the educators and the state in each of the three countries. Trust, social acceptability and the ability of the state to deliver EU values will differ across jurisdictions. The role of the educator within this matrix, in developing critical thinking opportunities, will vary and some of this will relate to the historic role of education in each country. Within each CoP, teachers have expressed challenges to implementing existing curricular requirements and introducing additional pedagogies and approaches should complement curricular demands.

Critical thinking is, in short, essential for addressing the challenges associated with decarbonisation and mineral extraction in Europe. It promotes a holistic and informed approach that considers the full spectrum of economic, environmental, social, and ethical factors involved. By involving teachers from a range of educational disciplines, critical thinking around sustainability challenges can be addressed through a cross curricular perspective. Being able to question decisions from an informed stance and enabling engagement, deliberative dialogue and discourse can only lead to more balanced and informed individual and collective decisions regarding pathways to achieving the EGD.

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