

Geothermal Education Across the IGCP-636 Network: A Global University Perspective

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INTRODUCTION

Geothermal energy plays a vital role in the global shift toward sustainable energy systems, requiring not only technological innovation but also a well-educated, multidisciplinary workforce. Yet despite growing interest in geothermal development, educational opportunities remain fragmented across the globe. While some programs are well-established and serve as key training hubs, others have collapsed following the withdrawal of funding (Newson et al. 2022; Newson and Greene 2019; Zarrouch, 2017). To address these challenges, the UNESCO-supported [IGCP Project 636 – Phase II: Geothermal Resources for Energy Transition](#) launched a global survey to assess the current landscape of geothermal education and identify gaps in access, curriculum content, and international collaboration.

METHODS AND RESULTS

A structured questionnaire was distributed between June and September 2025 to IGCP-636 member institutions as well as additional universities and research centers. A total of 54 complete responses were received, representing institutions from 27 countries across six continents (Figure 1). The survey included 18 questions covering topics such as institutional type, course offerings, academic levels, language of instruction, delivery formats, international collaboration, challenges faced, and support needs. Responses were analyzed using descriptive statistics to identify global trends and regional differences.

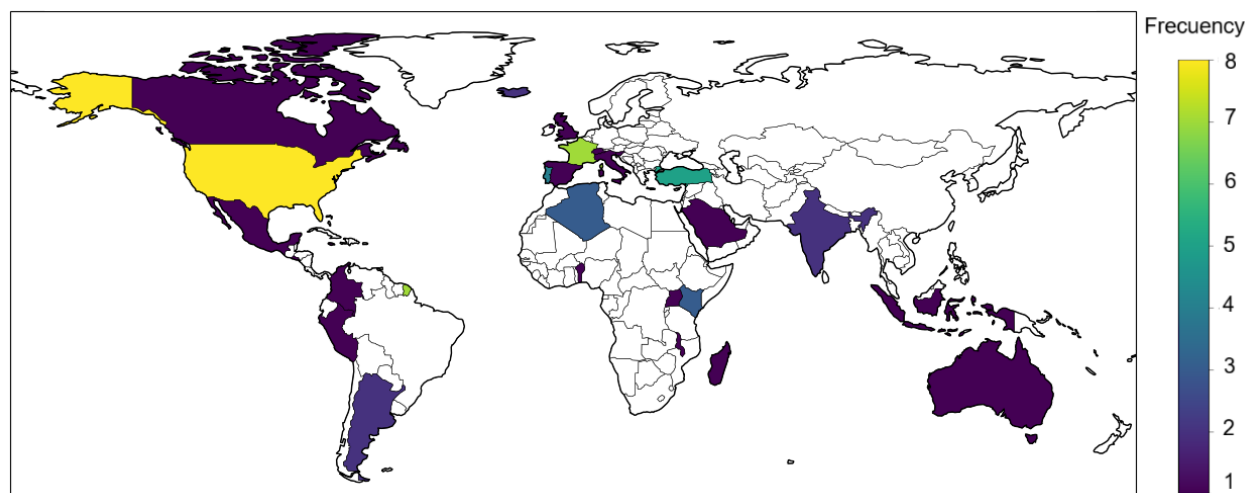


Figure 1. Distribution map of survey participants: number of answers received by country

The results reveal a diverse but uneven global landscape for geothermal education. Among respondents, 81% represented universities, 11% research centers, and 8% technical or vocational institutions. Approximately 77% of institutions reported offering geothermal-related courses, while the remaining 23% either planned to introduce them or cited insufficient institutional capacity.

Geothermal courses are most commonly offered at the master's (MSc) level (64%), followed by undergraduate (BSc) programs (43%) and doctoral (PhD) programs (38%). Only 15% of institutions reported offering continuing education or professional certificate programs. Most geothermal courses remain elective (72%), highlighting the limited integration of geothermal topics into core academic curricula.

The majority of geothermal courses are housed within Geosciences departments (74%), followed by Surface & Energy Systems Engineering (34%) and Subsurface Engineering (26%) (Figure 2). Other contributing departments include Environmental and Earth Systems, Social Sciences, and Law, though to a lesser extent.

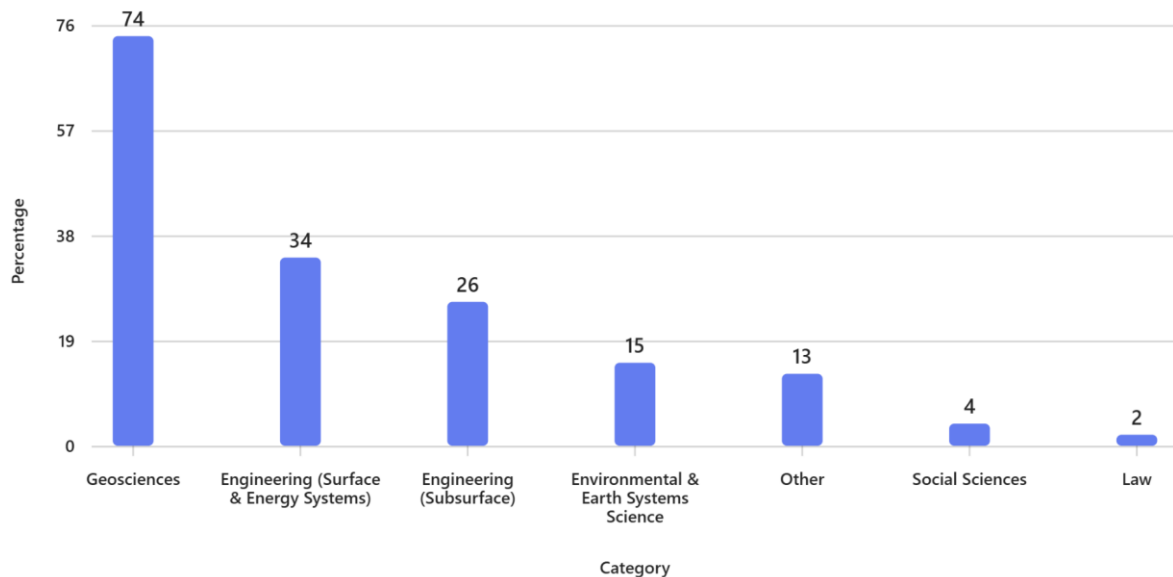


Figure 2. Distribution of departments offering geothermal-related courses.

English is the primary or partial language of instruction at 66% of institutions (Figure 3), underscoring the international nature of geothermal education. Meanwhile, 34% use only local languages, and 9.4% combine English with local instruction. However, just 23% of courses are offered online or in hybrid formats, limiting access for remote learners.

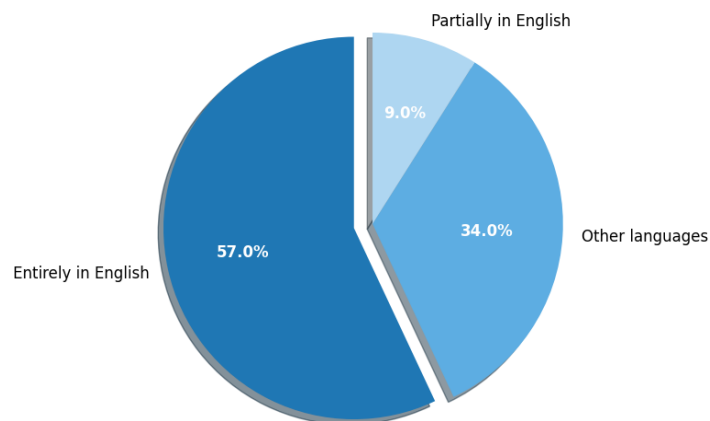


Figure 3. Language of instruction for geothermal-related courses.

About 41% of institutions reported active collaboration with international organizations like IGCP and [GEOTRAINET](#). These partnerships often take the form of joint fieldwork, exchange programs, and research-driven teaching, serving to strengthen both academic ties and practical experience.

The most frequently cited challenges are shown in Figure 4 and include a lack of funding or institutional support (53%), low awareness of geothermal energy (53%), and limited industry relevance or job visibility (49%). Additional issues reported by respondents include restricted access to field or laboratory facilities (34%) and a shortage of qualified instructors (30%). Several respondents also noted insufficient materials and limited visibility of geothermal career pathways as ongoing concerns.

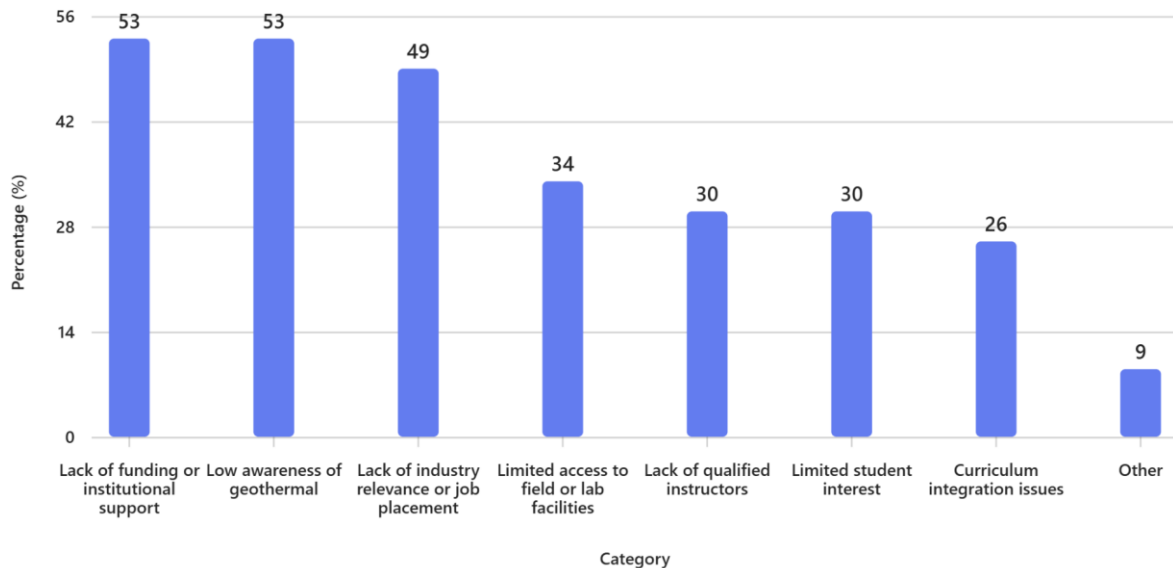


Figure 4. Reported challenges in delivering geothermal education.

DISCUSSION AND CONCLUSION

The survey outcomes reflect both progress and persistent fragmentation in geothermal education. The predominance of graduate-level programs suggests that geothermal topics are often treated as specialization modules rather than foundational subjects. This limits early exposure for undergraduate students and may reduce the recruitment pipeline for the geothermal workforce. To address this challenge, short introductory modules on geothermal energy should be incorporated into mandatory undergraduate courses, such as geology or geophysics lectures. Recent efforts in petroleum engineering programs have reached a similar conclusion: rather than offering geothermal as a standalone course, integrating geothermal concepts into drilling and completion classes is more effective in promoting the intended transfer of technology from the oil and gas sector to the geothermal industry (Teodoriu, 2022). Comparable patterns emerge in the [Geo3En](#) initiative, which found that European universities often silo geothermal content within advanced master's programs, prompting its consortium to design a shared, multi-institution MSc structure precisely to overcome fragmentation (Geo3En, 2022). The overlap with IGCP-636's findings indicates that structural gaps in geothermal exposure are consistently observed across both regional and global networks.

The gender composition of program leaders, as inferred from the survey, remains male-dominated and highlights the need for inclusivity efforts consistent with [Women in Geothermal](#) (WING) and UNESCO priorities. Although most respondents express willingness to collaborate internationally, structural barriers such as limited funding, administrative constraints, and the absence of standardized content continue to hinder collective curriculum development. Similar barriers were highlighted in the COMPASS project (Compass, 2023), which emphasized the need for coordinated training pathways for emerging topics like super-hot geothermal drilling, to ensure that institutions can collaborate effectively rather than developing isolated, inconsistent coursework.

The data also indicate that online and hybrid learning remain underutilized despite their potential to democratize access to specialized geothermal education. Developing open-source, modular teaching materials aligned with international standards could enhance both quality and accessibility. Several online learning options already exist but remain insufficiently known to the public. Examples include the *Aprende Geotermia* series (mainly in Spanish) and the *Geotheroom* series (mainly in English), both available on the YouTube channels of [AGEOCOL](#) and the [IGCP-636](#) project, respectively. Additional open-access platforms such as the IEA Geothermal webinar series and the World Bank and ESMAP geothermal training videos further support continuous learning. In addition to fully open resources, low-cost structured training opportunities, including GRC student workshops, also contribute to expanding access to geothermal education. These resources collectively demonstrate that the foundations for a globally shareable geothermal curriculum already exist; the remaining challenge is to curate, translate, and align them so institutions with limited staffing or funding can assemble complete, high-quality courses from interoperable components.

The Global Geothermal Education Survey provides the first consolidated overview of geothermal education across multiple continents. The findings highlight both strong institutional engagement and significant disparities in access, language, and teaching resources. Future initiatives should focus on establishing a shared repository of teaching modules, promoting exchange programs, and integrating geothermal topics into broader Earth and energy science curricula. A limitation of this study was the number of respondents: although the survey was shared through multiple tools (mailing lists, ThinkGeoEnergy bulletin, LinkedIn groups), responding to it remained voluntary and some courses may not have been included in this analysis.

Collaborative networks such as IGCP-636, the United States [GEODE Consortium](#), [GEORG](#) (Geothermal Research Cluster in Iceland), and the International Geothermal Association Academy can play central roles in harmonizing educational efforts, developing competency frameworks, and linking academic institutions with industry needs. International training platforms such as the [IHFC-IUGG](#) geothermal and heat flow summer schools and the [GRÓ Geothermal Training Programme](#) (GRÓ-GTP) provide intensive skill-building and could be strategically linked to these networks by aligning content, recognizing micro-credentials, and fostering alumni-to-university exchanges in order to bridge short-course trainings with long-term academic curricula.

Geothermal education cannot be examined separately from the broader state of geoscience education. Many of the challenges identified, including limited budgets, logistical constraints for fieldwork, and the need for interdisciplinary integration, are common across the geosciences. Geoscience research frequently intersects with national-level priorities such as energy resilience, Arctic studies, water security, and sustainable mining. These fields depend heavily on data collected from natural environments, which are costly and logistically demanding to access.

One sustainable way to address these challenges, particularly the need for greater financial support (54%) and field training opportunities (42%), is through strategic collaborations with national defense institutions such as the Air Force or Navy. Such partnerships can provide access to aerial perspectives, remote sensing training, and field-based learning opportunities at geothermal prototype facilities. In an era of constrained budgets, these collaborations offer a cost-effective pathway to high-quality education and research while also aligning with national security and sustainability goals. They enhance geoscience and geothermal education and contribute to resource management and environmental resilience.

Given the energy, resource, and environmental challenges of the coming decades, transforming geoscience education is increasingly essential. Ensuring that geoscientific knowledge is effectively communicated to the public and integrated into policy aligns with Sustainable Development Goal 4 of the United Nations 2030 Agenda (UNESCO & American Geophysical Union, 2023), which aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. By strengthening interdisciplinary collaboration and resource sharing, the global geothermal community can accelerate workforce readiness and contribute more effectively to the Sustainable Development Goals.

The survey therefore provides more than a snapshot; it delivers a mandate for coordinated action, showing that standardized curricula, globally shareable teaching resources, and tighter links between university programs and international training centers are essential if geothermal education is to scale at the pace required for the energy transition.

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