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Reimagining Geography Fieldwork in Higher Education: An Experiential, Inclusive, and Technology-Enhanced Learning Framework from Kerala, India

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Abstract

Fieldwork remains a fundamental component of geography education, enabling students to connect theoretical knowledge with real-world landscapes, environmental processes, and community contexts through experiential and enquiry-based learning. However, contemporary higher education faces several challenges in sustaining effective field-based learning, including limited institutional support, financial constraints, safety concerns, unequal participation, gender-based barriers, and disparities in access to technology. Despite its recognized pedagogical significance, empirical understanding of how these challenges influence geography fieldwork in the Indian higher education context, particularly in Kerala, remains limited. This study aims to critically examine current fieldwork practices in higher education institutions in Kerala and explore pathways for developing an experiential, inclusive, and technology-enhanced model of geography field education. The study employed a qualitative-dominant mixed-methods research design involving six higher education institutions affiliated with the University of Calicut, University of Kerala, and Kannur University during the academic year 2024 to 2025. Data were collected from 170 participants, including faculty members, students, curriculum planners, and technical staff, through surveys, interviews, focus group discussions, participant observations, and document analysis. Quantitative data were analyzed using descriptive statistics, while qualitative data were examined through thematic analysis using NVivo 12. The findings demonstrate that fieldwork significantly improves students' geographical understanding, with statistically significant gains observed in pre- and post-fieldwork assessments. However, the study identified institutional disparities in funding, GIS infrastructure, faculty training, and digital resources. Technology adoption remained uneven, and female students faced notable safety, mobility, and accessibility concerns. The study recommends curriculum integration, institutional investment, capacity-building, equitable technology access, gender-sensitive protocols, and interdisciplinary collaboration to strengthen fieldwork practices.

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Abstrak

Pekerjaan lapangan tetap menjadi komponen mendasar dalam pendidikan geografi yang memungkinkan mahasiswa menghubungkan pengetahuan teoritis dengan lanskap dunia nyata, proses lingkungan, dan konteks masyarakat melalui pembelajaran berbasis pengalaman dan penyelidikan. Namun, pendidikan tinggi masa kini menghadapi berbagai tantangan dalam mempertahankan pembelajaran berbasis lapangan yang efektif, termasuk

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terbatasnya dukungan dari lembaga, kendala keuangan, masalah keselamatan, ketimpangan partisipasi, hambatan berbasis gender, serta ketimpangan akses terhadap teknologi. Terlepas dari signifikansi pedagogisnya yang diakui, pemahaman empiris masih terbatas mengenai bagaimana tantangan-tantangan ini memengaruhi pelaksanaan dan transformasi pekerjaan lapangan geografi dalam konteks pendidikan tinggi di India, khususnya di Kerala. Studi ini bertujuan untuk menguji secara kritis praktik pekerjaan lapangan saat ini di perguruan tinggi di Kerala serta mengeksplorasi jalur untuk mengembangkan model pendidikan lapangan geografi berbasis pengalaman, inklusif, dan didukung teknologi. Penelitian ini menggunakan desain metode campuran yang didominasi kualitatif dengan melibatkan enam perguruan tinggi yang berafiliasi dengan University of Calicut, University of Kerala, dan Kannur University selama tahun akademik 2024 hingga 2025. Data dikumpulkan dari 170 partisipan, meliputi dosen, mahasiswa, perencana kurikulum, dan staf teknis melalui survei lembaga, wawancara semi-terstruktur, diskusi kelompok terarah, observasi partisipan, dan analisis dokumen. Data kuantitatif dianalisis menggunakan statistik deskriptif, sedangkan data kualitatif dianalisis melalui analisis tematik menggunakan NVivo 12. Hasil temuan menunjukkan bahwa pekerjaan lapangan secara signifikan meningkatkan pemahaman geografi mahasiswa, dengan peningkatan yang signifikan secara statistik yang terlihat pada penilaian sebelum dan sesudah pelaksanaan pekerjaan lapangan. Namun, ketimpangan antarlembaga teridentifikasi dalam hal dukungan pendanaan, infrastruktur SIG, pelatihan dosen, serta ketersediaan sumber daya digital. Adopsi teknologi masih belum merata, serta mahasiswa perempuan menghadapi kendala nyata terkait keselamatan, mobilitas, dan aksesibilitas. Studi ini menyimpulkan bahwa pendidikan lapangan geografi memerlukan transformasi dari kegiatan berkala menjadi praktik pembelajaran yang terpadu, inklusif, dan didukung secara digital. Studi ini merekomendasikan integrasi kurikulum, investasi institusional, peningkatan kapasitas dosen, akses setara terhadap teknologi spasial, protokol yang sensitif terhadap gender, kolaborasi lintas disiplin, serta evaluasi berkelanjutan untuk memperkuat praktik kerja lapangan di pendidikan tinggi di India.

INTRODUCTION

Fieldwork occupies a central and enduring position in geography education, serving as a critical pedagogical approach that bridges theoretical classroom knowledge with real-world landscapes, spatial processes, and community experiences. By enabling students to observe, analyze, and interpret geographical phenomena directly, field-based learning promotes experiential understanding, critical thinking, and the practical application of geographical concepts. Over time, fieldwork has evolved from traditional observation-based excursions into more structured, research-oriented learning practices that incorporate participatory approaches, geospatial technologies, and digital data collection methods. This transformation reflects the growing recognition that geography education must move beyond classroom-based theoretical instruction toward immersive, inclusive, and technology-supported learning environments that prepare students to address complex social, environmental, and spatial challenges. It provides students with direct, experiential learning opportunities that enhance their understanding of geographical concepts by immersing them in authentic environments. This immersion fosters an active, experiential learning mode, often described as transformative, allowing students to learn by doing and develop both subject-specific and transferable skills (France & Haigh, 2018; Hope, 2009).

Fieldwork strengthens the connection between theory and practice by contextualizing geographical knowledge in the field, where students can observe, analyze, and interpret spatial and environmental phenomena firsthand. This direct engagement helps students to develop geographical skills such as data collection, observation, and spatial reasoning, while also fostering critical thinking and problem-solving abilities through enquiry-driven approaches (Oost et al., 2011; Panelli & Welch, 2005). Moreover, fieldwork enhances students' affective responses: by encountering the lived realities of landscapes and communities, they can develop a deeper emotional and ethical understanding of human-environment interactions and place-based identities, which may challenge or reinforce their preconceptions (Hope, 2009).

Despite its recognized value, fieldwork faces challenges from institutional constraints, safety concerns, and changing higher education environments, which put pressure on its future viability and delivery. Nonetheless, scholars argue that fieldwork remains a fundamental pedagogical element vital for maintaining the discipline's identity and for promoting deep, transformative learning experiences that classroom teaching alone cannot offer

(Clark, 1996; Herrick, 2010). Successful fieldwork requires careful planning that integrates preparation, active engagement in the field, and thorough debriefing afterward to maximize learning outcomes (Kent et al., 1997).

Student perceptions consistently highlight the value of fieldwork in appreciating geographical reality, enhancing subject knowledge, acquiring technical and holistic skills, and fostering collaborative learning alongside peers and instructors. Nonetheless, fieldwork is time-intensive and may not benefit all learning styles equally, although most students tend to view it positively (Dunphy & Spellman, 2009; Fuller et al., 2003). Despite critiques that it may reinforce misconceptions, the consensus supports fieldwork as an indispensable educational strategy in geography that supports active, inquiry-led, and immersive learning experiences (Hope, 2009; Panelli & Welch, 2005).

Fieldwork in geography education is fundamentally valuable for bridging theoretical knowledge with real-world contexts, developing a wide range of cognitive, technical, affective, and social skills, and cultivating a deeper, more engaged understanding of geographical phenomena. It remains a cornerstone of geography pedagogy despite challenges and is vital for fostering the active, enquiry-driven learning that characterizes the discipline (France & Haigh, 2018; Herrick, 2010; Oost et al., 2011). Traditionally framed as an immersive, place-based pedagogical practice, fieldwork enables learners to develop spatial thinking, critical observation, and data-collection skills essential to geographic inquiry. However, despite its enduring relevance, fieldwork faces growing logistical, pedagogical, and ethical challenges, including accessibility, safety, gender, cost, and technological limitations. As educational institutions strive to democratize learning and adapt to rapidly evolving digital landscapes, there is an urgent need to reimagine fieldwork as a more inclusive, participatory, and technologically integrated component of geography education.

This paper critically explores how fieldwork in geography can be transformed to align with the principles of experiential learning, social equity, and digital innovation. Drawing on case studies, student reflections, and pedagogical literature, it examines the barriers to traditional fieldwork. It proposes a blended framework that leverages tools such as GIS, remote sensing, virtual field trips, and mobile-based data collection. It also highlights the importance of inclusivity, ethical engagement with communities, and culturally responsive practices. By advocating for a more flexible, inclusive, and technology-enabled approach, this paper aims to contribute to the development of a forward-looking fieldwork pedagogy that prepares students not only to observe and analyze geographical phenomena but also to engage meaningfully with the world around them.

Fieldwork is widely regarded as integral to geographical education, providing students with the invaluable opportunity to engage directly with landscapes, communities, and spatial processes beyond the confines of the classroom. This direct exposure to real-world settings enables students to experience geographical phenomena firsthand, which enhances their understanding and enjoyment. By seeing it for themselves, students develop both subject-specific and transferable skills, and fieldwork encourages active learning that directly connects theoretical knowledge to practical, lived realities (Fuller et al., 2003; Hope, 2009).

Student perceptions gathered during times when fieldwork was restricted due to events like the 2001 Foot and Mouth Disease outbreak in the UK underscore the overwhelmingly positive value students place on fieldwork. Key benefits identified include experiencing geographical reality, deepening subject knowledge, acquiring technical and holistic skills, and the social aspects of working collaboratively with peers and instructors. Although time-intensive, fieldwork is seen as a critical element that enriches the overall learning experience in geography and environmental sciences (Fuller et al., 2003). Lecturers echo this sentiment, emphasizing that the core pedagogical goals of fieldwork are to contextualize theory and provide students with subject-specific skills that classroom teaching alone cannot fully capture. While transferable skills development is often a secondary benefit, integrating fieldwork more holistically into pedagogic strategies remains an ongoing challenge (Scott et al., 2006).

Historically and contemporarily, fieldwork is recognized as a powerful educational tool that has evolved from teacher-centered approaches to those emphasizing active student investigation and enquiry. Modern fieldwork embraces ethical engagement with field sites and increasingly incorporates blended learning technologies. This evolution has helped move fieldwork from the curricular margins to a central position in geography education, underscoring its unique capacity to provide transformative, immersive learning experiences (France & Haigh, 2018).

Moreover, the inquiry-driven nature of fieldwork promotes cognitive and affective learning, in which students not only gather data and solve problems but also engage emotionally and ethically with places and people. This holistic approach fosters deeper geographical understanding and personal growth. However, some studies suggest that many geography teachers may struggle to fully realize these rich, enquiry-driven methods within school curricula (Oost et al., 2011).

Fieldwork remains a cornerstone of geographical education because it provides critical, active, and

immersive learning experiences that connect theoretical knowledge with real-world geographical phenomena. Through direct engagement with landscapes, communities, and spatial processes, field-based learning enhances students' conceptual understanding, analytical abilities, research skills, and environmental awareness (France & Haigh, 2018; Fuller et al., 2003; Hope, 2009). However, despite its recognized pedagogical value, contemporary fieldwork practices worldwide face several challenges, including accessibility constraints, unequal participation, safety concerns, financial limitations, and the need to integrate emerging digital technologies into field-based learning environments. These challenges have highlighted the need to rethink traditional approaches in favor of more inclusive, adaptive, and technology-supported models of geography education.

In the Indian higher education context, these global challenges are further shaped by institutional variations, resource limitations, and diverse socio-cultural conditions. Although fieldwork is an integral component of geography curricula, it is often implemented as a periodic academic activity rather than as a continuous experiential learning process. Issues related to infrastructure availability, faculty training, student accessibility, gender-sensitive planning, and technological preparedness influence the effectiveness and inclusiveness of field-based education. Within this broader context, Kerala provides a unique setting for examining the transformation of geography fieldwork due to its diverse ecological regions, complex human-environment interactions, and rich socio-cultural landscape. The state's varied physical and social environments offer significant opportunities for experiential geographical learning; however, existing fieldwork practices require further examination to understand their capacity to address contemporary educational demands.

Therefore, this study aims to critically examine the evolving role of fieldwork in geography education across higher education institutions in Kerala by investigating institutional support, pedagogical practices, student learning outcomes, technology integration, and inclusivity dimensions. By identifying existing gaps and opportunities, the study proposes an experiential, inclusive, and technologically enhanced framework for the future development of geography field education.

The current study investigates how geographic fieldwork can be transformed to meet contemporary challenges and learning outcomes. Drawing from a multi-institutional study involving students, faculty, curriculum planners, and technical staff across Kerala, the article investigates the infrastructure, pedagogical approaches, gendered experiences, and technological integration that shape field-based education. It emphasizes the importance of experiential and community-engaged learning while advocating for greater equity in access to tools and participation. In doing so, it calls for a paradigm shift one that reimagines geography fieldwork as an inclusive, learner-centered, and digitally empowered pedagogical practice suited to Kerala's unique environmental and educational landscape. Fieldwork in geography brings theory and reality together, allowing students to learn by doing. In the Indian academic landscape, however, fieldwork is often treated as an occasional or peripheral activity, despite India's vast geographic and cultural diversity. This paper assesses how evolving global fieldwork practices, such as active learning, team-based inquiry, and digital integration, can be applied meaningfully within the geography curriculum.

This study aims to critically examine current geography fieldwork practices in higher education institutions in Kerala, India, and to explore how field-based learning can be reoriented to achieve contemporary pedagogical outcomes within existing institutional, technological, and socio-cultural constraints. The study also seeks to generate broader insights relevant to geography education in the Indian higher education context. Specifically, the research examines the institutional and infrastructural factors influencing the organization and quality of geography fieldwork; evaluates the contribution of field-based learning to students' understanding of human-environment interactions and the development of cognitive, technical, affective, and social skills; investigates the extent, patterns, and inequalities associated with the adoption of digital and geospatial technologies, including gender-based differences in fieldwork participation and experiences; and identifies strategies for strengthening geography field education through curriculum integration, faculty capacity building, equitable access to technology, and gender-responsive and inclusive practices.

METHOD

Study Design

This study adopted a qualitative-dominant mixed-methods research design to critically examine the evolving role of fieldwork in geography education and explore pathways to develop an experiential, inclusive, and technology-enhanced model of field-based learning. The mixed-methods approach enabled integration of quantitative evidence from institutional surveys and student assessments with qualitative insights from semi-structured interviews, focus group discussions, participant observations, and document analysis. This methodological framework was selected to provide a comprehensive understanding of the institutional conditions, pedagogical practices, technological adoption, and inclusivity dimensions influencing contemporary geography fieldwork.

Study Area and Context

The study was conducted during the academic year 2024–2025 among higher education institutions offering geography programs in Kerala, India. Kerala was selected as the study context due to its diverse physical landscapes, complex human–environment interactions, and strong relevance for field-based geographical investigations. The study covered six higher education institutions affiliated with three major universities: the University of Calicut, University of Kerala, and Kannur University. These institutions were selected to represent variations in regional characteristics, institutional settings, and approaches to geography field education. Selecting multiple institutions enabled the study to capture diverse perspectives on the organization, implementation, and transformation of fieldwork practices.

Sampling Technique and Participants

A purposive sampling technique was used to select institutions and participants. Institutions were selected based on the availability of geography programs and their active involvement in field-based teaching and learning activities. Participants were chosen according to their direct engagement with geography fieldwork planning, implementation, learning processes, and technological support systems. The study included 170 participants: 36 geography faculty members, 120 students, 8 curriculum planners, and 6 technical staff members. Including these stakeholder groups allowed the research to incorporate multiple perspectives, including academic, learner, administrative, and technological viewpoints. Faculty members contributed insights into pedagogical practices and institutional arrangements; students represented fieldwork experiences and learning outcomes; curriculum planners provided perspectives on academic planning and curriculum development; and technical staff highlighted issues related to digital infrastructure and technology implementation.

Data Collection Instruments and Procedures

To achieve methodological triangulation, data were collected through multiple sources, including institutional surveys, semi-structured interviews, focus group discussions, participant observations, and document analysis. Institutional surveys assessed the availability of fieldwork-related infrastructure, financial support mechanisms, technological resources, faculty training opportunities, and institutional strategies for promoting inclusive field-based learning. The survey responses provided quantitative evidence regarding the current status of geography fieldwork facilities across the selected institutions. Semi-structured interviews were conducted with faculty members and academic stakeholders to explore their experiences, perceptions, and challenges in conducting geography fieldwork, focusing on fieldwork planning, pedagogical approaches, institutional limitations, and future opportunities to strengthen field-based education.

Focus group discussions were conducted with students to understand their experiences, perceptions, and challenges related to fieldwork participation, examining aspects such as learning benefits, accessibility, safety concerns, participation barriers, and gender-related experiences during field activities. Participant observations were conducted during field visits to examine fieldwork practices, student engagement, interaction patterns, gender dynamics, and the use of digital tools such as GPS, mobile GIS applications, and other technological resources, providing a contextual understanding of how field-based learning was implemented in practice. In addition, document and curriculum analysis was conducted using relevant academic and institutional materials, including geography syllabi, fieldwork guidelines, student field reports, risk assessment documents, and institutional fieldwork records to evaluate the formal structure and expectations associated with geography field education.

Ethical principles were strictly maintained throughout all stages of data collection. The study obtained necessary permissions from participating institutions before data collection. All participants were informed about the purpose of the study, and their voluntary participation was ensured through informed consent procedures. Confidentiality and anonymity were maintained during data handling, analysis, and reporting to protect respondents' privacy.

Assessment of Digital and Geospatial Technologies

The study further examined the role of digital and geospatial technologies in enhancing geography fieldwork. The assessment focused on the availability and application of technologies such as GPS-based mapping, mobile GIS applications, drone-based surveying, and digital data collection tools. The analysis considered the extent to which these technologies supported field data collection, spatial analysis, student engagement, and experiential learning. Particular attention was given to variations in technology adoption across institutions with different levels of infrastructure and resource availability.

Data Analysis

The collected data were analyzed using both quantitative and qualitative analytical approaches. Quantitative data obtained from institutional surveys and student assessments were analyzed using descriptive statistical techniques to identify patterns related to infrastructure availability, technology adoption, participant characteristics, and learning outcomes. Student knowledge development was evaluated by

comparing pre-fieldwork and post-fieldwork assessment scores. Qualitative data from interviews, focus group discussions, observations, and document analysis were analyzed using thematic analysis supported by NVivo 12 to identify recurring themes related to experiential learning, inclusivity, technological enhancement, institutional challenges, and future opportunities for geography fieldwork transformation. Integrating quantitative and qualitative findings enabled a holistic interpretation of the current state and future direction of geography field education.

Framework Development

Based on the findings derived from institutional assessments, participant experiences, learning outcomes, and technology evaluation, the study developed a framework for future geography fieldwork. The proposed framework emphasizes integrating experiential learning approaches, inclusive field practices, technology-supported learning environments, and sustainable access to field-based education. This framework aims to transform geography fieldwork from traditional observation-based activities into a more adaptive, equitable, and digitally enabled educational practice within Indian higher education. Figure 1 below presents the research workflow.

RESULT AND DISCUSSION

Result

The results provide empirical insights into the current status, challenges, and emerging opportunities associated with fieldwork-based geography education in Kerala. Based on the qualitative-dominant mixed-methods approach adopted in this research, findings were derived from institutional surveys, interviews, focus group discussions, participant observations, and document analysis conducted across six higher education institutions. The analysis incorporates perspectives from faculty members, students, curriculum planners, and technical staff to understand the multidimensional nature of fieldwork practices (Table 1). The results are organized into distinct thematic sections examining participant characteristics, institutional infrastructure, learning outcomes, technology integration, and inclusivity dimensions (Figure 2).

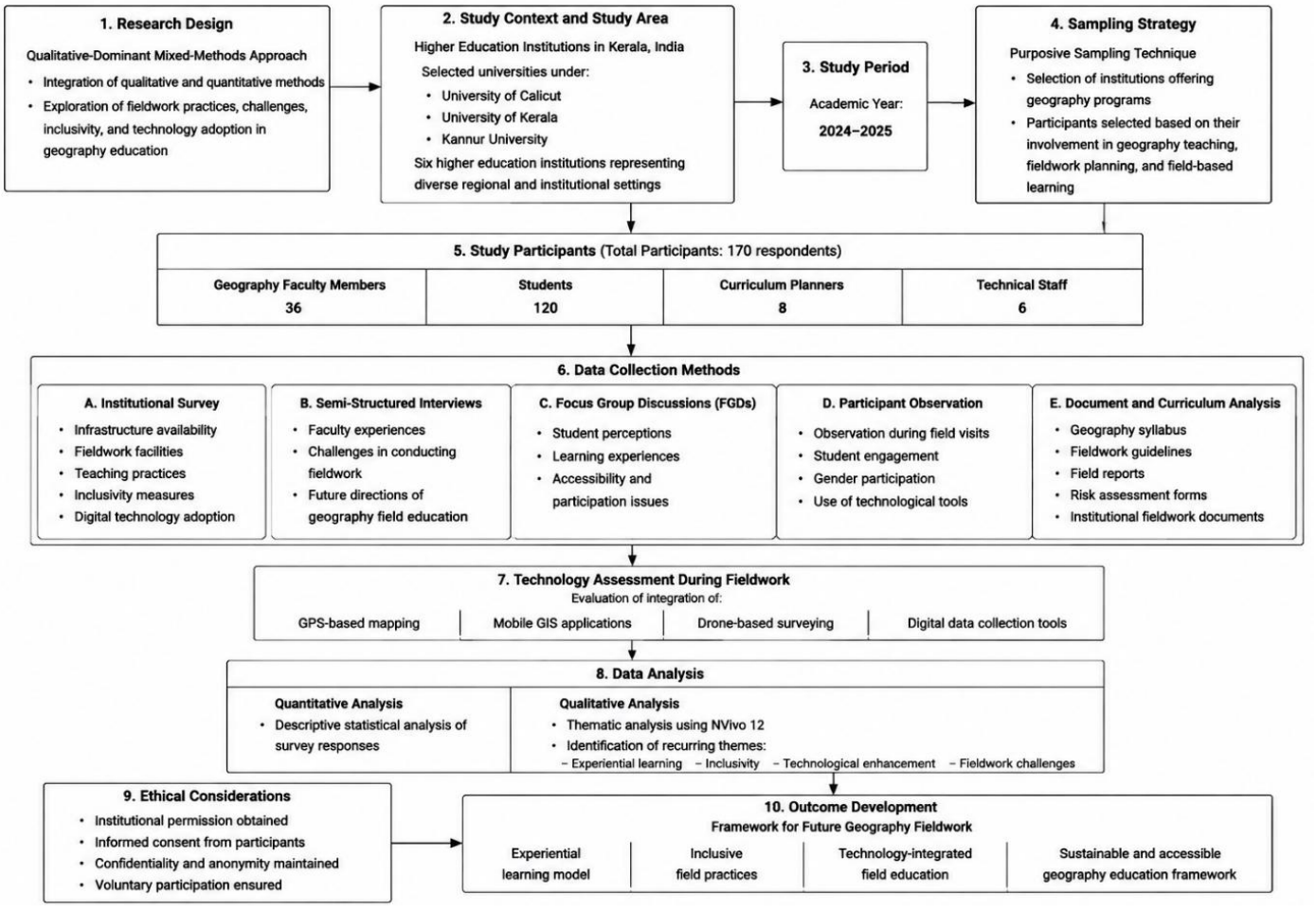

Figure 1. Methodological Framework

Table 1. Participant Demographics

Participant Group	Number of Participants	Percentage (%)	Gender Distribution (M/F)	Region	Academic/Professional Background
Faculty Members	36	21.18	24 M, 12 F	Kerala	60% Ph.D., 40% M.A./M.Sc.
Students	120	70.59	60 M, 60 F	Kerala	60% UG, 40% PG
Curriculum Planners	8	4.71	5 M, 3 F	Various regions	Educational Administrators
Technical Staff	6	3.52	4 M, 2 F	Kerala	Technical Experts
Total	**170**	**100**	**93 M, 77 F**		

Source: Field Survey, 2025.

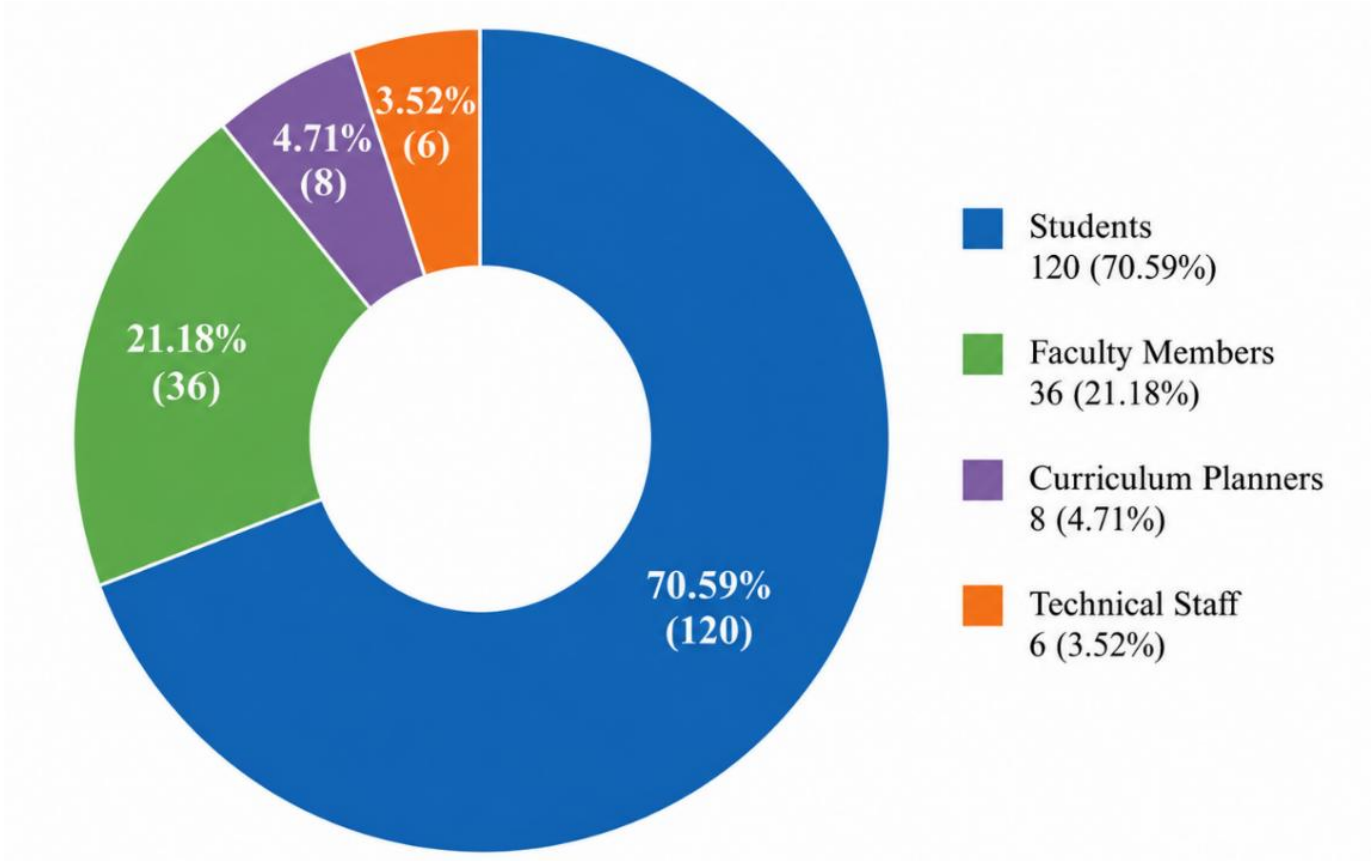

Figure 2. Participant Group Composition

The participant profile demonstrates a diverse and balanced representation of stakeholders involved in geography education and field-based learning practices, as illustrated in Table 1 and Figure 2. A total of 170 participants were included in the study, comprising 36 faculty members (21.18%), 120 students (70.59%), 8 curriculum planners (4.71%), and 6 technical staff members (3.52%). The student group constituted the largest proportion of respondents, reflecting the central role of learners in understanding fieldwork experiences, accessibility, and technology adoption in geography education. Faculty participants provided academic perspectives related to fieldwork planning, pedagogical approaches, and institutional practices, while curriculum planners contributed insights into syllabus design, policy considerations, and educational planning. Technical staff members represented the technological and operational aspects of integrating digital tools in field-based learning.

Overall, the sample included 93 male (54.71%) and 77 female (45.29%) participants, indicating relatively balanced gender representation (Figure 3). Among faculty members, 24 were male, and 12 were female, with 60% holding doctoral qualifications and 40% possessing Master's degrees, reflecting a highly qualified academic group. Student participants showed equal gender representation with 60 males and 60 females, encompassing learners from both undergraduate (60%) and postgraduate (40%) levels. Furthermore, curriculum planners included 5 male and 3 female educational administrators representing diverse regional contexts, while technical staff included 4 males and 2 females with specialized expertise in technological support systems.

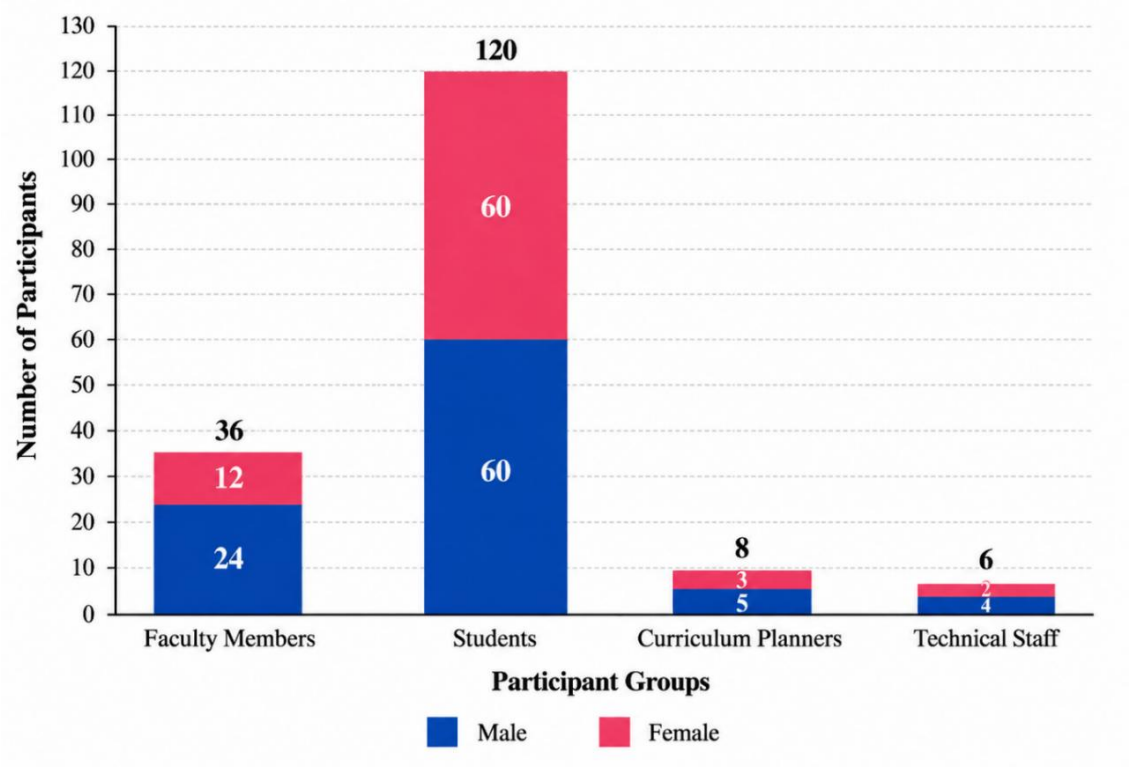

Figure 3. Gender Distribution

Table 2. Infrastructure and Pedagogical Support

Infrastructure/Support Feature	Percentage of Institutions Reporting Availability (%)
Fieldwork Budget (Annual)	40
GPS/Geospatial Tools (e.g., GIS)	25
Mobile Data or Tablets for Fieldwork	30
Fieldwork-Related Pedagogy Training for Faculty	35
Community Engagement in Fieldwork	50

Source: Field Survey, 2025.

The institutional assessment, based on survey responses across participating higher education institutions, indicates varied levels of preparedness and infrastructure for geography fieldwork, as detailed in Table 2. Community engagement support recorded the highest availability among the evaluated parameters, with 50% of institutions demonstrating established mechanisms to facilitate local interactions. Annual fieldwork budget support was available in 40% of the institutions, reflecting persistent financial constraints in sustaining comprehensive field activities.

Conversely, technological infrastructure and capacity-building opportunities remained notably limited across the surveyed campuses. Only 25% of institutions reported access to essential geospatial tools, such as GPS devices and GIS software, while 30% provided mobile data collection facilities or tablets for field application. Furthermore, only 35% of institutions offered formal fieldwork-related pedagogical training for faculty members. These empirical findings underscore substantial institutional disparities and highlight an urgent need for targeted financial allocation, modern digital infrastructure, and systematic faculty development to strengthen experiential, inclusive, and technology-enabled geography field education.

Table 3. Effect of Fieldwork Activities on Students' Knowledge Development: A Comparative Analysis of Pre-Test and Post-Test Scores

Study Region	Mean Pre-Test Score	Mean Post-Test Score	Improvement	Statistical Significance
Periyar Basin	50.30	72.10	21.80	$p < 0.01$
Chalakkudy River	52.70	75.40	22.70	$p < 0.01$
Chaliyar River	48.90	71.20	22.30	$p < 0.01$
Overall Mean (n = 120)	**50.60**	**73**	**22.40**	**$p < 0.01$**

Source: Field Survey, 2025.

The comparison of students' knowledge scores before and after fieldwork activities demonstrates a significant improvement in geographical understanding and experiential learning outcomes. The overall mean score increased from 50.60 in the pre-test to 73 in the post-test, representing a substantial gain of 22.40 points ($p < 0.01$). Region-wise analysis revealed consistent knowledge enhancement across all investigated fieldwork locations. The greatest improvement was observed in the Chalakkudy River region (+22.70 points), closely followed by the Chaliyar River (+22.30 points) and the Periyar Basin (+21.80 points). These statistically significant differences confirm that field-based learning activities substantially contributed to students' conceptual understanding, practical knowledge, and spatial interpretation of geographical processes, strongly supporting experiential fieldwork as an effective pedagogical approach in geography education.

Table 4. Technology Integration in Fieldwork

Technology Used in Fieldwork	Faculty Response (%)	Student Response (%)
GPS for Mapping	35	30
Mobile GIS Apps	20	25
Digital Drones for Mapping	10	5
Tablets for Data Collection	15	20
Social Media for Community Engagement	40	35

Source: Field Survey, 2025.

The study examined the extent and patterns of technology integration in fieldwork activities, revealing varied levels of adoption across the participating institutions as summarized in Table 4. Although digital tools were used during field exercises, their application was largely limited to basic devices such as mobile phones and digital cameras. Specifically, 35% of faculty members and 30% of students reported using GPS devices for mapping, while 20% of faculty and 25% of students used mobile GIS applications. Adoption of advanced tools remained minimal: only 10% of faculty and 5% of students reported using drone-based surveying, and 15% of faculty and 20% of students used tablets for mobile data collection. Interestingly, social media platforms emerged as a common medium for field outreach and community engagement, used by 40% of faculty and 35% of students. Crucially, technology adoption was markedly more prevalent in urban-based institutions, whereas rural and resource-constrained campuses encountered severe infrastructural barriers. This disparity underscores a distinct digital divide that impacts the overall quality, depth, and technological preparedness of experiential geography learning across diverse institutional contexts.

Table 5. Gendered Experiences in Fieldwork

Theme	Male Students (%)	Female Students (%)	Key Insights
Satisfaction with Fieldwork	80	65	Female students reported greater concerns regarding safety in remote areas.
Technology Access	70	60	Both genders reported limited access to technology, with females more likely to face mobility restrictions.
Community Engagement	75	80	Female students valued the personal engagement with local communities, especially in rural settings.

Source: Field Survey, 2025.

Focus group discussions highlighted notable gendered differences in students' fieldwork experiences, particularly concerning personal safety, spatial mobility, and resource accessibility, as summarized in Table 5. While 80% of male students expressed overall satisfaction with fieldwork activities, satisfaction among female students was lower at 65%, driven primarily by concerns about personal safety in remote and unfamiliar field sites. Regarding technological access, 70% of male and 60% of female students reported limited availability of digital tools. However, female students were disproportionately impacted by additional mobility constraints that further restricted their access to equipment during field exercises. Interestingly, both groups rated community engagement highly, with 75% of male and 80% of female students valuing local community interactions. Female students in particular found these engagements meaningful within rural contexts, suggesting that despite structural and logistical barriers, they frequently experienced a deeper connection through the participatory and social dimensions of field education.

The empirical findings confirm that experiential field-based learning significantly enhances students'

geographical knowledge, notably improving their conceptual understanding of flood risks and environmental change. While technology integration currently remains limited, tools such as mobile applications and GPS show strong potential for future pedagogical expansion. Furthermore, the distinct gendered experiences show that while field-based activities yield substantial educational benefits for all learners, institutional policies must explicitly address safety, physical access, and spatial mobility to foster truly inclusive and equitable learning environments.

Discussion

The findings of this study provide critical empirical insights into the evolving nature of geography fieldwork within higher education institutions in Kerala, highlighting an urgent need to reconsider traditional approaches to field-based learning. While fieldwork continues to play a central role in enhancing students' geographical understanding and experiential learning, its overall pedagogical effectiveness is heavily mediated by complex institutional, technological, and socio-cultural factors. The statistically significant improvements in student learning outcomes following field activities confirm the enduring pedagogical value of experiential learning. However, the identified structural gaps in institutional infrastructure, digital resource availability, faculty preparedness, and equitable participation emphasize the critical challenges that must be addressed to achieve a sustainable transformation of geography field education.

This discussion situates the empirical findings within the broader discourse on geography pedagogy, where field-based learning is increasingly recognized not merely as a passive observational exercise, but as an active, inquiry-led process of knowledge co-construction, critical spatial engagement, and environmental understanding. Contemporary fieldwork necessitates a deliberate shift from conventional teacher-centered excursions toward adaptive models that seamlessly integrate digital technologies, participatory methodologies, and inclusive field practices. In particular, the observed underutilization of GIS-based tools, mobile data collection applications, and advanced geospatial methods reflects a persistent institutional digital divide. Concurrently, gendered field experiences underscore the need to establish safer, more equitable, and spatially accessible field environments for all learners.

By incorporating multi-stakeholder perspectives from students, faculty members, curriculum planners, and technical staff, this study provides a comprehensive, multidimensional evaluation of the structural constraints and pedagogical opportunities shaping geography fieldwork in the Indian higher education context. The findings show that while field activities powerfully connect theoretical concepts with real-world geographical phenomena, their long-term viability depends on institutional capacity, resource allocation, technological readiness, and gender-responsive planning. To systematically interpret these dynamics, the subsequent discussion is structured around four interconnected thematic domains: (1) fieldwork as experiential knowledge development, (2) institutional readiness and infrastructural challenges, (3) technology-enabled transformation of geography field education, and (4) inclusivity and gender-responsive approaches to field-based learning.

The effectiveness of fieldwork in geography education is not universal, as structural factors including institutional capacity, resource accessibility, and broader social contexts significantly mediate it. Institutional capacity directly determines the quality, scope, and safety of field-based learning by governing the availability of funding, specialized infrastructure, administrative logistics, and qualified academic staff required to organize and supervise rigorous field excursions. Without robust institutional backing, logistical execution and safety coordination suffer, directly compromising the pedagogical value delivered to students (Cahuas & Levkoe, 2017; Panelli & Welch, 2005). Furthermore, access to critical resources such as geospatial technology, transport, site permissions, and specialized instruments shapes the boundaries of field investigation. Emerging educational technologies like virtual and augmented reality offer promising pathways to bridge these resource gaps, enabling simulated experiential learning when physical field access is constrained and expanding accessibility and student engagement (Hsiao, 2021; Jantjies et al., 2018).

Beyond material resources, broader socio-cultural dynamics and institutional cultures deeply influence how field-based learning operates. Critical educational perspectives show that field initiatives can inadvertently replicate systemic power dynamics, colonial legacies, and institutional inequities, affecting student participation and shaping how spatial knowledge is constructed and valued. Adopting critical service-learning frameworks aims to confront these socio-spatial injustices and foster social change through field activities, although such efforts face complex institutional resistance. Thus, social contexts govern not only physical access and participation, but also the epistemological framing of geographical knowledge (Cahuas & Levkoe, 2017; Esson, 2018). Moreover, motivational and pedagogical factors such as project coaching quality, curricular integration, supportive learning environments, and clear role expectations are essential for optimizing experiential project outcomes (Goldman et al., 2020). Ultimately, while field-based learning holds immense pedagogical promise through direct, active engagement,

its ultimate success depends on institutional capacity to provide systemic support, innovate learning resources, and negotiate social dimensions to cultivate equitable educational experiences (Cahuas & Levkoe, 2017; Jantjies et al., 2018; Panelli & Welch, 2005).

The multi-stakeholder design of this study, encompassing faculty members, students, curriculum planners, and technical staff, ensured a comprehensive, systemic evaluation of geography fieldwork practices. Including academically qualified faculty alongside balanced student cohorts strengthens the credibility of these insights. At the same time, curriculum planners and technical personnel provided essential perspectives on policy, syllabus integration, digital infrastructure, and operational constraints. This holistic approach confirms that fieldwork effectiveness extends well beyond individual classroom instruction and relies heavily on macro-level institutional coordination and policy environments. Indeed, higher education field practice has undergone significant transformations in response to shifting institutional funding models and policy mandates, presenting both structural challenges and opportunities for innovative pedagogy, assessment, and organizational planning (Clark, 1996).

Systemic support mechanisms including dedicated budgets, risk management frameworks, and administrative assistance are vital to ensure fieldwork is delivered safely, effectively, and with pedagogical integrity. Without such backing, field-based education risks becoming marginalized despite its acknowledged academic value. Institutional coordination plays a pivotal role in embedding field exercises seamlessly into geography curricula, aligning them with programmatic learning outcomes, supporting faculty through capacity building, and negotiating site access with external stakeholders amidst rising financial and logistical pressures (Herrick, 2010; I. Scott et al., 2006). Empirical evidence consistently shows that while students deeply appreciate the active learning, technical skill acquisition, transferable competency, and social collaboration enabled by field activities, the quality of these learning outcomes remains contingent on institutions' capacity to plan, resource, and sustain field programs (Fuller et al., 2003).

Moreover, effective institutional coordination can enhance enquiry-driven, immersive fieldwork practices that stimulate both cognitive and affective development in students. Such systemic approaches help move fieldwork from a peripheral to a core component of geography education, ensuring it adapts to contemporary academic and social contexts while maintaining its foundational role in shaping geographical understanding (France & Haigh, 2018; Oost et al., 2011). A multi-stakeholder, institutionally coordinated approach is essential for sustaining and enhancing fieldwork's effectiveness. This approach facilitates not only the practical delivery of field experiences but also supports pedagogical innovation, ethical engagement, and the cultivation of skills and values critical to geographical education (Clark, 1996; Herrick, 2010).

The analysis of infrastructure and pedagogical support reveals considerable disparities across institutions. Limited availability of dedicated fieldwork budgets, technological tools, and faculty training suggests that institutional planning frameworks often undervalue field-based learning. Although community engagement emerged as a relatively stronger component, inconsistent financial and technical support constrains the depth and frequency of field activities. These findings suggest that while institutions widely recognize the pedagogical value of fieldwork as a vital component of geography education, structural limitations hinder its systematic integration into geography curricula. Challenges include limited funding for field activities, a lack of professional development opportunities for educators, and difficulties in curriculum design that fully embeds fieldwork as an integral rather than peripheral element (Kent et al., 1997; Panelli & Welch, 2005; Wilson et al., 2016).

Strengthening institutional investment is essential to ensure access to adequate resources, logistical support, and innovative teaching technologies such as virtual field guides, which can augment traditional fieldwork experiences and help overcome funding pressures. Additionally, faculty capacity-building through professional development and collaborative teaching approaches fosters improved pedagogical strategies and enhances educators' ability to guide inquiry-based field studies effectively. This ensures the delivery of quality experiential learning that aligns with contemporary educational paradigms emphasizing student-centered constructivist learning and interdisciplinarity (Cliffe, 2017; Gray et al., 2019; Oost et al., 2011).

Current findings highlight the importance of curriculum models that structurally integrate fieldwork, moving beyond viewing it as an adjunct to classroom teaching and instead embedding it as a core learning methodology. Programs that implement active learning modes where students investigate real-world phenomena in situ foster deeper understanding and transformative learning experiences. This requires institutional commitment to revise curricula, create enabling policies, and provide ongoing support for fieldwork activities (France & Haigh, 2018; Kent et al., 1997). Sustaining high-quality experiential learning through fieldwork necessitates enhanced institutional commitment and the continuous development of faculty capabilities. Such measures enable robust, enquiry-driven, and inclusive field education that equips geography students with critical thinking, problem-solving, and transferable skills

essential for their academic and professional futures (Panelli & Welch, 2005; Wilson et al., 2016).

Despite these structural constraints, the results demonstrate that fieldwork has a substantial positive impact on student knowledge and engagement. The statistically significant improvements observed in pre- and post-test scores across all regions indicate that experiential learning enhances students' understanding of complex environmental processes such as flood risks, hydrological systems, and environmental change. The consistent learning gains observed across different river basins indicate that fieldwork facilitates a meaningful connection between abstract theory and tangible environmental phenomena, fostering a deeper, more integrated understanding (Chitty & Hesp, 2024; Scott et al., 2011).

Fieldwork's immersive nature engages multiple cognitive and affective domains, promoting both practical and critical thinking skills through active participation in environmental inquiry. Studies show that students enjoy and value fieldwork experiences, which contribute to enhanced recall and application of knowledge, surpassing what is achieved through classroom-based learning alone (Boyle et al., 2007; Scott et al., 2011). Moreover, preparatory and reflective practices further enrich learning by mitigating the challenges posed by the novelty of unfamiliar field environments (Cotton, 2009). Overall, experiential learning through fieldwork enables students to integrate and apply complex environmental concepts effectively, fostering robust understanding across diverse ecological contexts through active, situated learning (Elwood, 2004; Munge et al., 2017). This reinforces the pedagogical argument that experiential learning is particularly effective for geography and environmental studies, where spatial and process-based understanding is critical.

The findings on technology integration reveal a mixed landscape, characterized by varying levels of adoption and access to digital tools. While tools such as GPS, mobile GIS applications, and social media are being used to facilitate field data collection, collaborative learning, and community engagement, advanced technologies like drones and tablets remain underutilized, limiting opportunities for comprehensive spatial data collection and real-time analysis (Park, 2021; Shakhislam et al., 2024; Theng et al., 2007).

The adoption of digital tools tends to be higher in urban institutions than in rural or resource-constrained settings, illustrating a digital divide that significantly influences the quality and equity of student learning experiences. This divide encompasses disparities in access to hardware, software, reliable internet connectivity, and faculty training, which collectively constrain the effective use of geospatial technologies in less resourced contexts (Afzal et al., 2023; Brian et al., 2024).

While social media platforms have emerged as flexible and accessible means of communication and engagement in field activities, limited use of analytical geospatial tools restricts students' capacity to perform advanced spatial analyses and critically interpret data. This gap narrows the integration of contemporary geospatial practices into the geography curriculum and hampers the development of students' spatial thinking and technical competencies. Enhancing educator competencies and incorporating technology standards can help bridge these gaps by promoting consistent and equitable technology use across educational settings (Nellis, 1994; Swain & Pearson, 2002). Efforts to increase access, provide professional development, and promote innovative curricular integration of geospatial technologies, including drones, mobile GIS, and analytic platforms, are essential to align fieldwork with modern geographic information practices and foster inclusive, high-quality experiential learning environments (De Lázaro Torres et al., 2017; Mexhuani, 2024).

Gendered experiences in fieldwork present complex challenges that affect participation and learning satisfaction, particularly for female students. While both male and female students gain educational benefits from field-based activities, female students often report lower overall satisfaction because of concerns about safety, mobility, and unequal access to resources. These disparities are deeply rooted in structural and social constraints, such as patriarchal norms and gendered power relations, which manifest in spatial limitations, risk exposure, and restricted mobility, especially in rural or traditional contexts (Eriksen, 2013; Loukaitou-Sideris, 2016).

Research shows that women's mobility is more constrained by safety concerns and sociocultural norms than men's, reducing freedom of movement during fieldwork and affecting comfort and learning experiences. This is compounded by inequalities in access to transport and resources, which vary further by factors such as income, age, and ethnicity (Gauvin et al., 2020; Khadka et al., 2014). For non-binary and gender nonconforming individuals, these mobility limitations are exacerbated by experiences of harassment and discrimination, highlighting the need for broader inclusivity (Ivanova & O'Hern, 2024).

Despite these challenges, female students often demonstrate a strong appreciation for participatory, community-engaged aspects of fieldwork, which can foster meaningful, socially embedded learning experiences. This suggests that socially integrative pedagogical designs can mitigate some gender-based constraints by providing supportive learning environment

Figure 4. Recommendation for Enhancing Field-Based Geography Education

and opportunities for collaborative knowledge production (Eriksen, 2013).

Addressing these gendered disparities requires explicit, gender-sensitive planning in fieldwork design and implementation. This includes establishing robust safety protocols, improving logistical support such as access to safe transport and secure accommodations, and ensuring equitable access to technology and other learning tools. Moreover, fostering supportive networks and mentoring can empower female and gender-diverse students to navigate and challenge structural barriers in field settings (Eriksen, 2013; Najafizada et al., 2019). Creating inclusive and supportive fieldwork learning environments necessitates a comprehensive understanding of gendered risks and mobility challenges, coupled with proactive institutional strategies to promote safety, equity, and meaningful participation for all genders (Eriksen, 2013; Loukaitou-Sideris, 2016).

Taken together, the findings confirm that fieldwork plays a critical role in enhancing geography education by promoting experiential learning, student engagement, and contextual understanding of environmental issues. However, uneven institutional support, limited access to technology, and gender-based challenges limit its full potential. Addressing these issues through targeted investment, pedagogical innovation, and inclusive planning (Figure 4) can significantly strengthen the role of fieldwork in geography education and prepare students to engage more effectively with complex environmental challenges such as floods and climate-related risks.

To address the empirical gaps identified in this study and foster a transformative, inclusive, and technology-enabled model of field-based education, this study proposes a holistic action framework (Figure 4). First, regarding curriculum integration, fieldwork must be embedded systematically as a core pedagogical component across undergraduate and postgraduate geography programs rather than treated as an occasional excursion. Institutions should align field studies with clear academic objectives and local socio-environmental challenges. Second, bridging the technological divide requires strategic investment in accessible digital tools,

including mobile GIS applications, GPS units, and affordable geospatial technologies suitable for resource-constrained and remote settings. Prioritizing faculty development and technical training is equally critical to ensure that educators can effectively integrate these digital tools into inquiry-based field teaching.

Third, promoting inclusive and gender-sensitive fieldwork practices requires explicit safety protocols, secure transportation, appropriate accommodations, and balanced group dynamics to mitigate safety and mobility barriers faced by female students, while incorporating socio-emotional support into field design. Fourth, strengthening institutional support requires allocating dedicated annual budgets for field logistics, safety equipment, and technological tools, supported by robust administrative frameworks that make regular fieldwork feasible across all higher education settings. Fifth, enhancing interdisciplinary collaboration with local governments, non-governmental organizations, and local communities can expand resource availability while embedding student learning within real-world problem-solving contexts. Finally, establishing mechanisms for continuous evaluation and multi-stakeholder feedback from students, faculty, and administrators will enable ongoing program refinement, ensuring that geography field education remains responsive, equitable, and aligned with contemporary environmental realities.

CONCLUSION

Fieldwork remains an essential component of geography education, providing a unique platform for students to engage with real-world landscapes, environmental processes, and communities beyond the classroom. This study demonstrates that field-based learning significantly contributes to the development of students' geographical understanding, practical skills, critical thinking abilities, and experiential knowledge. The statistically significant improvement observed in students' pre- and post-fieldwork assessment scores confirms the effectiveness of field activities as a meaningful pedagogical approach for strengthening conceptual and applied learning in geography.

However, the findings also reveal that the effectiveness and sustainability of geography fieldwork are mediated by institutional capacity, resource availability, technological preparedness, and socio-cultural conditions. Although fieldwork practices are widely recognized across higher education institutions in Kerala, substantial variations exist in infrastructure support, financial resources, faculty training opportunities, and access to digital technologies. The limited adoption of advanced geospatial tools, including mobile GIS, drone-based surveying, and digital data collection platforms, indicates an urgent need for stronger technological integration to align geography field education with contemporary scientific and educational requirements.

Furthermore, the study highlights the critical importance of inclusivity in field-based learning. Gender-related concerns, particularly regarding safety, physical mobility, and equitable access to resources, demonstrate that effective fieldwork planning must extend beyond academic objectives to incorporate socially responsive practices. Ensuring safe, accessible, and supportive field environments is essential for enabling equal participation among diverse student groups. Ultimately, the future of geography field education requires a transition from traditional, occasional excursions toward an integrated, experiential, inclusive, and technology-supported learning framework. Strengthening institutional investment, building faculty capacity, embedding digital geospatial technologies into curricula, and adopting gender-responsive field protocols are crucial steps toward achieving this transformation, offering a scalable model for higher education institutions across India.

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AUTHOR CONTRIBUTIONS

Jayarajan Kunnampalli: conceptualization, methodology, data collection, experimentation, data analysis, and writing—original draft preparation; **Dhanya Punnoli**: methodology, validation, supervision, and writing—review and editing; **Sreelu Sreepadi**: methodological development, data analysis, interpretation of results, and literature review; **Sreelesh Tharayankoth**: supervision, validation, and writing—review and editing. All authors have read and agreed to the published version of the manuscript.

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CONFLICT OF INTEREST

All authors declare that they have no conflicts of interest.

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