**Centre for Integrated Earth System Science Education (iEarth)**

**VISION:** iEarth will create a student-centred, innovative learning environment for future Earth system scientists and citizens to meet complex societal challenges and opportunities. This will be done by promoting active learning and real-world problem-solving through a nationally integrated Earth system science education with a global perspective.

Earth System Science (ESS) is the study of natural systems closely linked to human activity and decision-making. The challenges imposed by a changing climate, resource demands, and shifting energy landscapes acutely highlight the interdependence between human society and our planet, as reflected in the United Nations Sustainable Development Goals (SDGs). ESS education is a precondition for societal resilience and environmental safety and underpins major energy and resource-based industries. This is particularly evident in Norway with our strong economic reliance on an oil and gas industry that depends on Earth science expertise. At the same time, Norway’s ambition to become a global environmental leader has sparked the need for renewed thinking about the future of ESS education and its role in society.

In iEarth, students and instructors will join forces with public and private stakeholders to build an educational system that connects many of the SDGs with our renewed ESS education goals, such as tackling climate change and working to preserve our land and oceans. Modern Earth science takes a systems perspective, which treats physical, chemical, and biological processes, including human activities, as components of a complex, dynamical system. ESS education thus provides unique opportunities for students to learn sought-after skills associated with real-world, complex problem-solving. However, existing curricula and teaching practices are too fragmented for these opportunities to be harnessed. Our goal is to unleash this potential and foster student engagement, self-motivation, and employability in an authentic learning environment. By transforming our curricula and our culture for teaching and learning, we aim to prepare students for a wider range of job opportunities and to empower the next generation of citizens to help solve the great challenges of the 21st century.

We specifically aim to realise our vision by the following strategies: 1) transform national Earth science curricula through a competence-oriented curriculum redesign; 2) create an effective learning environment by engaging students as partners in the educational process; 3) build a collaborative, innovative, research-based culture for teaching and learning among students and staff; 4) enhance student learning in the field by systematically investigating the effectiveness of field-based learning activities; and 5) develop internship practices and alumni networks as natural interfaces between students and future employers.

iEarth will provide the framework and resources required to implement these strategies, monitor and evaluate progress, and share best practices nationally and internationally. This application for a
Centre for Excellence in Education hosted by the Department of Earth Science at the University of Bergen (UiB) is a joint effort by four key national institutions (forming the consortium) engaged in ESS education in Norway: the Department of Earth Science and the Geophysical Institute at UiB, the Department of Geosciences at the University of Oslo (UiO), the Department of Geosciences at The Arctic University of Norway (UiT), and the Departments of Arctic Geology and Arctic Geophysics at the University Centre in Svalbard (UNIS). We have a number of collaborators in order to ensure pedagogic excellence and innovation, including the Higher Education Research Unit at UiB, the Competence Centre for Research in Natural Sciences and Technology at UiO, the Centre for Learning and Education at UiO, the Centres for Excellence in Education, BioCEED at UiB, CCSE at UiO, Vis-innovation at UiB, the Centre for the Science of Learning and Technology at UiB, and the Institute for Teaching Excellence and Faculty Development at the University of Massachusetts Amherst in the United States. International collaborators on education include Lund University’s Department of Geology, the University of Iceland’s Faculty of Earth Sciences, the University of Copenhagen’s Department of Science Education, and Washington College in the United States. Furthermore, the iEarth consortium has strong links with partners in industry, stakeholders, and public administrations to help develop teaching and learning approaches tailored to ESS. Contributing funding to iEarth will provide us with the means to establish an unprecedented Nordic competence centre for ESS learning capable of contributing to the international society of scholarship of teaching and learning (SoTL).

In the following sections, we provide a baseline describing the current status of our teaching and learning culture and establish a set of benchmarks to help us envision what ESS education at UiB, UiT, UiO, and UNIS should look like five years from now. The key is that both students and instructors should be able to envisage the starting point, the journey, and the goal, and they should be able to measure the progress along the way.

I. Documentation of quality in existing teaching and education

Following the previous call for SFU proposals in 2016, when our application was positively assessed, we systematically formalised and developed the national iEarth consortium (www.iearth.no). During the past two years, we have focused on promoting students as partners in the educational process, put more emphasis on increasing interaction with society, piloted SoTL projects, promoted new student-active learning methods, and disseminated our activities nationally and internationally [e.g. 1]. Our teaching staff is required to take 20 ECTS in basic pedagogies for higher education to secure competence and interest in the pedagogies of the consortium. We started mapping the curriculum with the goal of making it transparent at the undergraduate level, operated an annual ‘Learning Forum’ and instructor retreat for the exchange of teaching experiences, developed and improved our field teaching and evaluation, developed alumni networks, prepared for a ‘flipped classroom’ methodology, performed baseline surveys among staff and students [2], started
the development of an innovative programme for undergraduate research, and held frequent international webinars as part of our curriculum\textsuperscript{1}. We have introduced innovative student-active learning methods in several of our courses. We have developed the first Massive Open Online Course\textsuperscript{2} on climate change that is now part of our curriculum and our students have been involved in outreach and dissemination through Scisnack\textsuperscript{3}. GeOracle meetings, in which students help students with assignments and projects, and staff meetings addressing innovative ways of teaching and learning have been successful undertakings. Our staff is engaged in outreach and dissemination activities through national and international media. Students and instructors have been active in National Research Schools, such as the Research school on changing climates in the coupled earth system (CHESS) and the Norwegian Research School for Dynamics and Evolution of Earth and Planets (DEEP). In 2018, one of our professors was among the first five to be accepted into the Pedagogical Academy of UiB’s Faculty of Mathematics and Natural Sciences. Several of our staff members have received teaching awards, including the Olav Thon Foundation Award for outstanding teaching and the Norwegian Geological Society prize for outstanding teaching practices. In 2017, our new geohazard course was awarded for its learning environment\textsuperscript{4}. Fundamental to our approach is the assumption that research excellence may serve as a stepping stone to excellence in teaching. The consortium’s shared excellence is evident in the form of research and innovation activities, participation in four Norwegian Centres of Research Excellence\textsuperscript{5}, and numerous European Research Council (ERC) grants, including the only two ERC synergy grants given to Nordic countries\textsuperscript{6}. The consortium has shared access to state-of-the-art research infrastructure, including “field stations” from Finse in southern Norway to Arctic Svalbard, fully equipped research vessels and state-of-the-art laboratory facilities for training and undergraduate research experiences.

The iEarth consortium represents a strong tradition of research-based education where the students are exposed to a broad range of teaching and assessment methods. We prioritise field teaching as excursions, fieldwork and cruises as part of their education to enhance hands-on experience with research methods in Earth science. Students in geophysical fluid dynamics have a strong mathematics and physics background that is put into practice through fieldwork, laboratory studies, and computational exercises. These on-site learning environments also support the development of transferable skills and lifelong learning [3, 4]. In some curricula, students are involved in research-based activities modelled after course-based undergraduate research experience

\textsuperscript{1} https://www.geo.umass.edu/climate/webinar.html.
\textsuperscript{2} https://www.futurelearn.com/courses/causes-of-climate-change.
\textsuperscript{3} http://www.scisnack.com.
\textsuperscript{4} https://www.uib.no/en/node/109509
\textsuperscript{5} Bjerknes Centre for Climate Research (BCCR), Centre for Arctic Gas Hydrate, Environment and Climate (CAGE), Centre for Earth Evolution and Dynamics (CEED), and the Centre for Geobiology (CGB).
\textsuperscript{6} Ice2ice at UiB and WHOLE SUN at UiO.
This will be implemented in all bachelor’s programmes in iEarth. Furthermore, iEarth is focused on developing independent thinking and introducing students to the culture and methods of research to promote student learning. This is achieved through discussions, critical reading, writing, peer-review evaluations, and feedback in collegial environments. The focus on promoting student learning also includes small research projects during which students receive support and follow-up from staff and graduate students during the research process. These projects aim to help students identify research questions, develop aims and objectives, learn new techniques, collect data in the field and/or in the lab, analyse data, conduct numerical simulations, and write scientific reports and journal papers that contain hypotheses for testing and/or falsification. A variety of teaching and assessment methods are combined in most courses to foster and evaluate multiple skills and knowledge types.

Based on the evaluation of our study programmes and the study completion rates in the consortium, the present Earth science education provides a solid platform from which to launch iEarth. Surveys indicate that graduates are satisfied with the content, relevance, and quality of their education, which they believe provides valuable transferrable skills, such as analytical, communication, and cooperative skills. However, despite all the positive qualities mentioned above, the Earth science curricula are too compartmentalised to provide the educational coherence, progression and integration required to meet societal needs. For example, students outside of geophysics see a need for enhanced computational and data analysis skills [6]. We are confident that our educational provision is relevant to the continued development of our educational programmes. Despite this strong standing, we realise that the scope and practices of ESS education is in need of a major transformation, if we are to step up to societal challenges and demands for new forms of Earth science expertise, the transition to a more sustainable and low-emission society addressed in the UN’s SDGs, and development in didactic and digital educational methods. We are currently performing a baseline survey within the entire iEarth consortium where we map the qualities of current curricula, the teaching and learning environment, and the future needs for ESS education among both staff and students. The overall aim is to assess the status of teaching and learning culture, provide input and targets for future development, and monitor progress towards excellence in teaching and learning [2].

II. Centre plan — strategy, plan for innovation, and dissemination in iEarth

iEarth will have five interdependent progress domains (PD1-5) led by teams of passionate and highly qualified staff members from all four partner institutions. Our approach is to build on the strengths and resources available in the consortium and collectively transform our Earth system education into a transparent curriculum with the flexibility to develop cross-disciplinary and inter-institutional/national courses. We will develop the governance of iEarth through student involvement, shared leadership, shared resources, pedagogical expertise, and ‘Geolearning Forums’ within the consortium.
Progress Domain 1: Shaping the future (led by Bjarte Hannisdal, UiB)

**Keywords:** Systems thinking, real-world problem-solving, employability, curriculum redesign

Through iEarth, students and instructors will join forces with public and private stakeholders to build an ESS education that rests on five pillars of human and societal relevance: geohazards, resources, energy, environment, and climate. From a pedagogical point of view, ESS has a great advantage in being inherently tangible in terms of human experience, which enhances student motivation. On the other hand, the complexity of dynamical Earth systems poses a formidable challenge. Overcoming this challenge requires knowledge integration across the domains of temporal and spatial thinking [7], field learning (PD4), and systems thinking [8]. The integration of computational learning practices [9] and proficiency in mathematical and computational methods is needed to progress from our innate tendency to perceive events sequentially in linear causal chains towards an interconnected, dynamical process-like notion of causality that is characteristic of complex Earth systems [10, 11].

**Objectives:** We aim to empower students through an integrated systems perspective and sought-after general skills that underpin their employability whilst strengthening the craftsmanship needed to become a scientist. To pursue this dual goal, students and instructors will take a fresh look at problem-solving activities encountered in ESS curricula and recast them as instances of a general form of ill-structured problems encountered in real-world situations [12]. Unlike classic textbook problems, the key components of realistic, ill-structured problem-solving [13] require training on how to define unclear problems and goals, work with incomplete and uncertain information, evaluate multiple possible solutions, and build arguments. These components characterise both authentic scientific research problems, as well as other real-world problems in the workplace and society at large. iEarth is in a unique position to provide student-active problem-solving learning by mobilising a set of key scientific practices [14], such as asking questions, performing investigations (field, lab, numerical, theoretical), acquiring, analysing, and interpreting data, using and producing models, creating explanations, and communicating results. To foster student learning, motivation, and engagement, iEarth will involve students in the co-creation of a learning environment (PD2 and PD3) that supports this type of training [15, 16], including authentic, contextualised problems, sustained investigation, collaboration, expert coaching, scaffolding, and integrated, formative assessment.

**Progress Domain 1 — key steps:** PD1.1. *Identify needs and gather data.* A core team, including an iEarth PhD position, will lead the effort to gather internal data across the consortium (e.g., conducting SWOT analyses and change readiness surveys, defining a baseline for the status of the education), as well as external data (e.g., literature, international peer institutions, societal stakeholders). We will identify key factors relevant for motivating instructors to engage in a transformative redesign process [17] that aims to reorient a traditionally content-based curriculum (‘science as encyclopaedia’).
towards general competencies and skills (‘science as process’). PD1.2. *Curriculum mapping*. We will develop a framework for competence-oriented curriculum mapping that integrates institutional (e.g., course descriptions), instructor (e.g., teaching methods), and student (e.g., assessment) perspectives. To facilitate the change process, we will implement a very concise set of mapping categories (e.g., competence level, explicit/implicit, learning outcome coverage, assessment) [18, 19]. PD1.3. *Student involvement*. Students will be engaged in the redesign process by critically exploring formative assessment (e.g., rubrics) in a competence-oriented curriculum. By clarifying the relation between forms of self- and peer-assessment and learning outcomes directly relevant to real-world problems and their own employability, students will be active agents in the assessment of their own learning [20]. Thus, transforming the students’ approaches to learning (PD2) will be a key component of the curriculum redesign process. PD1.4. *Dissemination, evaluation, and revision*. Through monitoring and visual analytics, we will use feedback and evaluation data to learn, adjust, and revise the curriculum redesign process in five-year cycles. Given the rarity of competence-oriented Earth science curriculum redesign [21], our innovative approach will be the topic of an iEarth PhD-SoTL project. We envisage that this tool can be expanded across iEarth and implemented to monitor and measure progress and success.

**Progress Domain 2: A learning environment for students (led by Anders Schomacker, UiT)**

**Keywords:** Student engagement, student voice, independent learning, high-impact practices, course-based research experience

Society, employers, and academia require self-motivated, independent learners capable of lifelong learning. To foster independent learning, students need to be partners in the educational process [22], which is a cornerstone of the iEarth vision.

**Objectives:** Students will take part in their education as an active process of inquiry and not just a collection of disconnected facts. Traditional teacher-centred instruction will be reoriented towards student-active learning through high-impact practices [23], including authentic problem-solving [12] and undergraduate research experience [24]. By situating learning activities in an authentic context, students can experience the same problem-solving challenges in their education that they encounter in real life [4]. A curriculum that involves real-world ill-structured problems (PD1) requires an effective learning environment for students, including student-instructor interaction, collaborative learning, sustained investigation, reflection and argumentation, high expectations, scaffolding, and inclusive learning [3].

**Progress Domain 2 — key steps:** PD2.1 *Engage students as partners*. To increase the extent to which students understand and engage with their own educational goals, we will encourage peer instruction and assessment and ensure that student feedback to instructors more accurately targets the
learning process [25, 26]. A key factor in transforming students’ approaches to learning is to shift emphasis from traditional final exams towards integrated, formative assessment [27, 28]. Instructors will provide support (PD3) for students to develop learning strategies and self-efficacy. Independent learning and autonomy, which strengthen intrinsic motivation, engagement, and deep learning [11], will also support researcher training in iEarth by providing students with the freedom to pursue areas of special interest and encouraging them to initiate their own scientific projects. PD2.2 *Provide course-based undergraduate research experience.* We will establish such a framework early through repeated exposure to collaborative research projects in the auditorium, the field, and in the lab. By using technologically enhanced classrooms and real-world observational data, students will progress towards expert behaviour; they will do this by asking questions, framing and testing hypotheses, analysing data, producing models, making decisions under uncertainty, designing and performing experiments, building argumentation, and communicating results. The implementation of undergraduate research experiences in the curriculum will be the subject for PhD-driven SoTL projects and one postdoctoral fellowship. PD2.3 *Optimise instructional technologies and physical learning spaces.* Achieving our goals will require robust teaching and learning technologies and flexible physical learning spaces. We aim to create a physical environment that facilitates flipped classroom approaches [29], group work, lectures, webinars, mobile learning, and virtual reality, as well as hands-on experience with diverse sample materials, current measurement data, high-performance computing, and state-of-the-art laboratories. To this end, iEarth will prioritise the development of digital platforms by building on expertise at DigUiB and SLATE to disseminate learning resources, online collaboration, and webinars, to evaluate the use of new technologies, and to provide structured feedback and evaluation tools.

**Progress Domain 3: A learning environment for instructors (led by Mattias Lundmark, UiO)**

**Keywords:** Scholarship of teaching and learning, collaborative teaching culture, evidence-based teaching practices, Earth science education research, student involvement, dissemination

iEarth supports the development of excellence in teaching and learning as a collegial undertaking, and a key goal is to build a collaborative culture for teaching and learning capable of implementing an ESS perspective across the curriculum, developing shared courses across several institutions, and carrying out operational teaching development.

**Objectives:** We will build a collaborative and knowledge-based culture for teaching by emphasising an exchange of ideas and experiences, innovation, and the continuous development of teaching practices. Teaching development has always been a part of teaching but has commonly had a private and non-systematic character, decoupled from educational science. To address this, iEarth will support the systematic investigation of the relationship between learning activities and learning outcomes, as well as the sharing of results through the scholarship of teaching and learning [30]. We
will use the nascent national focus on excellence in teaching in higher education, which is reflected in, for example, new guidelines for academic hiring and promotion, [31] to drive institutional and staff ambitions in teaching development. One important goal is to support teaching and teaching portfolio development for temporary and permanent staff promotion and to have systems promoting staff to qualify for ETP status (not implemented at all institutions yet). We will develop shared courses across the consortium (PD2) to allow iEarth partners to provide a wider range of both highly specialised courses for postgraduate Earth science students and courses that reach across disciplinary boundaries for adapting to societal needs. We will engage students as participants and partners in teaching development by directly involving them in co-creating and evaluating existing and novel teaching practices, technologies, and materials [32, 33], thus giving students greater ownership of and influence on their education. We will build a national and Nordic Earth science education research group for higher education teaching. This will be done in collaboration with our partners in Sweden, Denmark, and Iceland. We will also work towards establishing a Nordic Earth science education research school based on the same model as CHESS.

**Progress Domain 3 — key steps:** PD 3.1 *Catalyse cultural change for instructors at a national level in ESS education.* This will be done through 1) organising annual ‘Geolearning Forums’ for national and international partners and collaborators (organised as a pilot in 2018 for the first time), as well as inter- and intra-institution-based seminars and workshops aimed at both permanent and temporary staff (in collaboration with DEEP, CHESS, BioCEED, etc.); 2) developing a virtual competence centre for knowledge and resource sharing for instructors and students; 3) employing SoTL as a means to change the perspective of both instructors and students towards a more collaborative and research-like view of Earth science teaching; 4) involving students as partners and participants in teaching and in teaching development through such things as giving rapid feedback on teaching initiatives, conducting micro-investigations of teaching and learning, and developing teaching materials; and 5) providing support and resources for teaching development (project funds have been allocated in the iEarth budget), such as time (e.g., educational sabbaticals), teaching and pedagogical support, and support staff in achieving ETP status. PD3.2 *Develop generic approaches for cross-disciplinary courses distributed among the consortium partners.* This will be done by supporting and coordinating the development of two consortium-wide courses among the entire iEarth team in geohazards and climate change. Following the experiences from these courses, we will review and develop sustainable course formats and communicate best practices. Based on feedback from students, alumni, and stakeholders, we will identify both specialised and interdisciplinary themes suitable for shared courses and initiate the further development of similar courses across the iEarth consortium. PD 3.3 *Develop educational research and initiate SoTL activities in all progress domains in iEarth.* We will build a national ESS education research group for university teaching that will
investigate and track the longitudinal changes in teaching culture and practices. This will be implemented through the hiring of five adjunct professors, five doctoral projects, and two postdoctoral fellowships that will explore and develop ESS teaching and learning in a Norwegian context through tailored SoTL activities and, based on the outcome of this, will develop innovative solutions to challenges of shared courses in Earth sciences. Dissemination will be secured through the establishment of a Nordic research school with partners in Sweden (Lund), Denmark (Copenhagen), and Iceland (Reykjavik).

PD3.4 Appoint an education chair at each institution. The chair will be responsible for: 1) initiating, coordinating, and supporting teaching collaborations, ‘Geolearning Forums’, and science education research; 2) supporting and motivating staff to take part in SoTL projects; 3) following up on baseline surveys and measuring progress in the iEarth project; and 4) coordinating and supporting the dissemination of research and practices nationally and internationally. PD3.5 Dissemination, evaluation, and revision. iEarth will foster a culture change where instructors participate in an increased number of conversations on advances in teaching and learning locally, nationally, and internationally. We will develop new arenas for these conversations in addition to those at MNT nationally and ISSOTL internationally. An important part of evaluating this culture change will be to develop tools that can monitor progress in this participation (as listed in PD1).

Progress Domain 4: Field-based education (led by Lena Håkansson, UNIS)

Keywords: Deep learning in the field, location-focused field learning, assessment, digitalisation and technology, development of unique learning environments

Traditionally, field-based education has been an important component in Earth science curricula [34] by providing practice and a foundation for the development of specific skills within the discipline [7, 35, 36]. Organising and conducting field teaching is, however, a demand on resources and recent economic constraints on Earth science university education have caused a significant reduction in all field activities. However, it is a very important component, and field-based education in marine and terrestrial environments pushes students across important thresholds to give them deep learning of Earth science. Moreover, it drives interaction through observation, instrumentation, and technology in real research environments further in allow students to practice and develop those skills in authentic settings [37, 38]. Learning in the field provides students with a unique opportunity to apply the techniques and concepts that they have worked with theoretically [7, 35, 36].

Objectives: We aim to place our field-based education on a more solid foundation by expanding research-based knowledge on effective student learning in the field. To achieve this expansion within realistic economic constraints we need to make efficient use of local field laboratories and instrumentation. We will develop, test and evaluate digital tools and assessment methods together
with the DIKU project AKTIV-2018/10172, a collaboration between UiB and UNIS focusing on constructive alignment between field learning outcomes and assessment methods.

Progress Domain 4 — key steps: PD4.1 Develop field-learning outcomes and test and implement assessment methods for these learning outcomes. To improve learning outcomes and justify the priority of field-based education in future curricula, we need to document student-learning processes in the field. Our aims are to strengthen the knowledge base about field learning and use this actively in the development as a resource for instructors to align courses with field-based learning activities. A core team, including an iEarth PhD, will lead this work. PD4.2 Establish local field laboratories in the landscape around the iEarth institutions. This will enable location-based learning and a sustainable increase in field learning, which is emphasised in the ESS approach. Expanding the use of local field laboratories and instrumented sites and networks will facilitate repeated training of basic skills, thus allowing students to perform fieldwork independently with other students in well-known areas following earlier, more guided fieldwork. Local field laboratories will also be a hub for the development and implementation of new teaching methods and assessment strategies inspired by the Real Data initiative\(^7\) at UiB. PD4.3 Establish a comprehensive baseline study on the position of fieldwork in university Earth science education in Norway and on Svalbard. Recent literature has demonstrated the importance of fieldwork [4]. However, as resources become scarce, field experiences are often targeted for cuts [39]. Therefore, it is crucial to document and develop these activities and to set up SoTL activities to increase the awareness of field teaching in ESS education [38]. One PhD position will be allocated to this activity. PD4.4 Test and document the use of digital methods to improve student field learning. Significant technological advances often result from a series of evolutionary steps rather than breakthroughs. To take part in such evolutionary steps, the academic institutions need to be more hands-on when new technology is emerging. In Earth science, and especially within geomatics, this development has emerged in the industry as the implementation of new technology in field learning at the university level, but this lags behind the development in industry. iEarth will strive to close this gap and collaborate with external partners, such as NVE and NGU, alumni (PD5), and stakeholders, to share competence and explore the use of drones, virtual-reality field-trip preparation in our field education [1].

Progress Domain 5: Networking and society contact (led by Iver Martens, UiT)

Keywords: Alumni, internships, communication, employability and dissemination

Alumni connections are important resources that can contribute to educational development [1] and can be an engaged, supportive network that can secure communication between iEarth and society. If communication ends once graduates leave an institution, their understanding of the

\(^7\) https://ektedata.uib.no/
university will become stale. Instead, they should be kept involved so they can remain engaged and be kept abreast of the progress of the university. Good alumni relationships bring many benefits to both the institution and the alumni. Talented alumni will have a wealth of experience and skills to share with current students via talks, newsletters, or meetings. Two-way interaction between higher education institutions and society is essential to secure broad societal relevance of ESS education. iEarth will be an important asset for dissemination and two-way communication at every scale between institutions in higher education, research, industry, the public sector, and NGOs.

Traditionally, Norway has seen few alumni networks, but in the iEarth consortium, each member institution will promote, establish, and develop an alumni network. For the relationship between stakeholders and the academic community, trust, honesty, a safe space for deliberation, and the acknowledgement of the others’ competence must be nurtured. These are the core themes to be developed in the alumni network. By building on industry contacts through alumni networks, we will promote and implement internships as an integrated part of ESS education (PD2) and empower our graduates to clearly articulate their skills and the broad societal relevance of their education. We have already established an open 10 ETC course code and started drafting internship projects together with NVE on geohazards. Such experiences will contribute to enlarging the students’ skills bases, building awareness of competence, and enabling students to trust their own capabilities. Many employers use internships as a fast track into their tenure programmes for hiring new staff.

**Objectives:** We aim to develop alumni networks at the iEarth institutions to ensure good contact between academia and potential employers. We aim to generate databases and social channels for alumni information by creating spaces for meetings and outreach between candidates and the alumni networks. Based on industry and stakeholder contacts, we will establish routines and put internship solutions into play across the consortium and its alumni networks for the various study programmes.

**Progress Domain 5 — key steps:** PD5.1. *Establish and develop alumni networks at individual institutions.* A key network component is advocating for alumni to offer practical support for students in work placements and help them launch their work careers. At UiT, the network has already been established by using LinkedIn and by holding annual alumni gatherings. Based on their experience, the entire iEarth consortium will start developing an alumni network. PD5.2. *Establish, develop, and maintain the internship capacity.* This will be done together with partners from industry and potential employers, such as consultant companies and governmental agencies. We will establish a database for internship possibilities and design an overview of potential employers and contacts, develop routines for student-employer contact, and disseminate the internship schemes to potential employers. Internships should ideally be aligned with the employer’s wishes and be in parallel with iEarth’s ideas on undergraduate research experiences, arranged as small-scale research projects. Student interns will perform well-defined research projects at the host institution, among industry partners, and with
stakeholders. In addition, we will establish an annual networking day (career day) at each institution to secure communication and share experiences from the internship programme.

**III. Organisation of the iEarth consortium**

Securing an organisation able to run a centre and fulfil the goals of this proposal require clear management. The centre manager/leader (Jostein Bakke, UiB) and his deputy (Hanne Hvidtfeldt Christiansen, UNIS) will be responsible for project leadership. They will report to the consortium and the advisory board, monitor progress through communication with education chairs, communicate with DIKU, manage internal projects, and manage iEarth financially and administratively. The consortium structure is outlined in Figure 1 and indicates the arrangement of the centre and the interaction between the centre board, the advisory board, and the management. The advisory board, whose members are representatives from our international collaborators, will be a particularly important asset that will monitor and advice iEarth activities. The centre board and the involvement of heads of departments in iEarth are crucial for securing the iEarth legacy after the project period. Dissemination of the results is a key component of iEarth and will be targeted in each PD. The outcome of key steps in each PD will be subject to monitoring, and we will measure success using visual analytical tools as described in PD2. The legacy of iEarth can only be maintained if our research-based findings are implemented as best practices in the consortium as part of strategies at each institution.

![Diagram showing the organisation of the iEarth consortium](image)

**Figure 1. Annual Geolearning Forums are important for dissemination and for communication within the consortium. Building a collegium of PhDs, postdocs, and adjunct professors is crucial for executing the key steps in each PD and for running internal development projects.**
References:
iEarth budget from autumn 2020 to spring 2025

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<td>In-kind</td>
<td>1268</td>
<td>8999</td>
<td>10600</td>
<td>10250</td>
<td>10136</td>
<td>2639</td>
<td>43 880</td>
</tr>
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</table>
**Personnel: Management:** Scientific project manager and centre leader (50 %), administrative project coordinator (100 %) and 4 education chairs (50 %) representing each of the institutions will lead the centre management. The education chairs will oversee project progress and manage development of PDs at their respective institutions, thus ensuring implementation of iEarth policy throughout the consortium. In addition, 1 lab technician (20%) will lead technical field and laboratory development throughout the consortium. Each of the PD leaders (20 %) will oversee development. *Pedagogic research and development:* funding of five PhD students (1 in kind from each of the consortium institutions and one in addition from UiB) working in the projects focusing on teaching methods and innovation supervised by department of Pedagogics, UiB and SLATE in collaboration with Earth scientists from the consortium (all PDs). In addition, we will hire three post docs for taking part in the undergraduate research experiences including responsibility for setting up systematic tools for evaluation (all PDs). To secure international dissemination and quality control in iEarth three 20% adjunct professors as in kind from UiB/UiO and one over the iEarth budget financed from DIKU will be guest lectures on courses and take part in the supervision of PhD candidates. These adjunct professors will in kind aid iEarth in upholding a high international standard as well as promote exchange of teaching practices across the collaborating partners. *In kind:* Teaching time from all scientific staff and lowered institutional overhead costs, including office space, IT, HR and administrative services as well as publication and research services. Expertise from department of Pedagogics, UiB. Student guidance and administrative support.

**Development and innovation:** This post will cover the day-to-day cost of running the centre as well as infrastructure digital tools and travel expenses for retreats and conferences. The largest expense included in this post is internal projects (5 mill. NOK total), which will function as a fund the PDs can apply for in the start-up phase of each internal project. This post is crucial for implementing the new curricula and will cover teaching assistance, production of instruction videos, software development, implementing of digital tools in teaching, development of visual evaluation tools etc. *In kind:* use of webinar facilities at UiB.

**Teaching:** Equipment for webinar facilities (600 000 NOK) and expenses related to internships and travel. *In kind:* Access to laboratories, ship time and field cost. **Dissemination:** The costs associated with dissemination are mainly for organizing and participation in workshops and international conferences regarding Earth science education as well as a virtual competence centre as a shared resource in the consortium and for collaborators.

**Plan for financial resource acquisition:** DIKU; 40 mill. NOK In kind from UiB and consortium members 43.8 mill. NOK.