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Ausbildung

Education

Shape2Gether – Joint Education for Sustainable Development with Geotechnologies and Serious Games

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Summary

Despite growing recognition of the importance to foster students' agency in climate change education, approaches that are both integrated and interdisciplinary remain limited. This paper addresses this gap by examining an interdisciplinary approach, developed within the "Shape2Gether" project, that combines geotechnologies, education for sustainable development (ESD), experiential learning, and game-based methods within a coherent pedagogical framework for sustainability and climate-change education. It examines how this approach can help students develop knowledge, confidence, and action competence in communicating complex sustainability issues.

Shape2Gether (S2G) is a three-year Erasmus+ project uniting seven European universities. The project aims to support students in becoming "agents of change" capable of critically engaging with, communicating, and addressing complex socio-environmental challenges. Across three international summer schools (held in Norway, Malta, and Germany), students participated in a cumulative learning trajectory supported by online preparation and inter-summer-school assignments. They worked with advanced geotechnologies, engaged in place-based fieldwork, collaborated in interdisciplinary teams, and used discursive game design to communicate sustainability issues through virtual reality tours, multimedia products, and playable game prototypes.

Student evaluations indicate strong gains in sustainability literacy, technological skills, intercultural competence, and confidence in communicating climate-change topics. Participants particularly valued experiential learning, international collaboration, and creative communication methods, which together fostered action competence and personal growth.

A systematic review of European study programmes revealed that although geotechnologies, sustainability education, and game-based learning are each well represented individually, no existing long-term higher-education programme integrates all three domains. This highlights a structural educational gap and further supports the relevance of the Shape2Gether pedagogical model.

The findings provide both empirical evidence and conceptual guidance for designing a joint international curriculum that combines geotechnologies, education for sustainable development, experiential methods, and discursive game design. The paper contributes to the conceptualisation of students as "agents of change", provides empirical insights into the implementation of an interdisciplinary curriculum prototype, and lays the groundwork for the development of a joint international higher-education programme.

Keywords: Shape2Gether, geotechnologies, experiental learning, climate change communication, interdisciplinary collaboration, place-based education, gamified education, curriculum prototype

Zusammenfassung

"Shape2Gether" – Integrierte und Interdisziplinäre Bildung für nachhaltige Entwicklung mit Geotechnologien und spielbasierten Methoden

Trotz der zunehmenden Erkenntnis, wie wichtig es ist, die Eigeninitiative der Studierenden in der Klimabildung zu fördern, gibt es nach wie vor nur wenige Ansätze, die sowohl integriert als auch interdisziplinär sind. Dieser Beitrag befasst sich mit dieser Lücke, indem er einen im Rahmen des „Shape2Gether"-Projekts entwickelten interdisziplinären Ansatz untersucht, der Geotechnologien, Bildung für nachhaltige Entwicklung (BNE), erfahrungsorientiertes Lernen und spielbasierte Methoden in einem kohärenten pädagogischen Rahmen vereint. Es wird untersucht, wie dieser Ansatz den Studierenden helfen kann, Wissen, Selbstvertrauen und Handlungskompetenz bei der Vermittlung komplexer Nachhaltigkeitsthemen zu entwickeln.

„Shape2Gether" (S2G) ist ein dreijähriges Erasmus+-Projekt, an dem sieben europäische Hochschulen zusammenarbeiten. Ziel ist es, Studierende dabei zu unterstützen, zu „Agent/innen des Wandels" zu werden. Diese sollen in der Lage sein, sich kritisch mit komplexen sozio-ökologischen Herausforderungen auseinanderzusetzen, darüber zu kommunizieren und zu deren Bewältigung aktiv beizutragen. Im Rahmen von drei internationalen Sommerschulen (in Norwegen, Malta und Deutschland) nahmen Studierende an einem aufeinander aufbauenden Lernprogramm teil, das durch Online-Vorbereitung und Aufgaben zwischen den Sommerschulen ergänzt wurde. Sie arbeiteten mit fortschrittlichen Geotechnologien, führten ortsbezogene Feldforschung durch, kooperierten in interdisziplinären Teams und nutzten diskursives Spieldesign, um Nachhaltigkeitsthemen mithilfe von Virtual-Reality-Touren, multimedialen Produkten und spielbaren Prototypen zu vermitteln.

Die Bewertungen der Studierenden zeigen deutliche Fortschritte in den Bereichen Nachhaltigkeitskompetenz, technologische Fähigkeiten, interkulturelle Kompetenz und Selbstvertrauen bei der Vermittlung von Themen rund um den Klimawandel. Die Teilnehmenden schätzten insbesondere erfahrungsorientiertes Lernen, internationale Zusammenarbeit und kreative Kommunikationsmethoden, die gemeinsam Handlungskompetenz und persönliche Entwicklung förderten.

Eine systematische Analyse europäischer Studienprogramme zeigte, dass Geotechnologien, Nachhaltigkeitsbildung und spielbasiertes Lernen zwar jeweils gut vertreten sind, es jedoch kein bestehendes langfristiges Hochschulprogramm gibt, das alle drei Bereiche integriert. Dies verdeutlicht eine strukturelle Bildungslücke und unterstreicht die Relevanz des pädagogischen Modells des Projektes „Shape2Gether".

Die Ergebnisse liefern sowohl empirische Evidenz als auch konzeptionelle Leitlinien für die Entwicklung eines gemeinsamen internationalen Curriculums, das Geotechnologien, BNE, erfahrungsorientierte Methoden und diskursives Spieldesign integriert. Der vorliegende Beitrag soll zur Konzeptualisierung von Studierenden als „Agenten des Wandels" beitragen, liefert empirische Einblicke in die Umsetzung eines interdisziplinären Lehrplanprototyps und legt den Grundstein für die Entwicklung eines gemeinsamen internationalen Hochschulprogramms.

Schlagwörter: „Shape2Gether“, Geotechnologien, erfahrungsorientiertes Lernen, Klimawandelkommunikation, interdisziplinäre Zusammenarbeit, ortsbezogene Bildung, spielbasiertes Lernen, Curriculumkonzept

1 Introduction

Making young people aware of and actively involved in the transition to sustainable living is important, because climate change demands action in the form of both mitigation and adaptation. Meanwhile, young people experience feelings of resignation, which are implicitly or unknowingly reinforced by media representations of climate change (Bosschaart 2019) and by textbooks that often present a fixed future (Pauw 2015). Both give students a feeling that they have no or little influence on "what is to come". This lack of agency that young people may feel is reinforced by the alarming stage climate change is reaching and which coincides with other global crises such as the global decline in natural spaces, Covid-19 pandemic and various armed conflicts.

Education for Sustainable Development (ESD) provides a framework to address this perceived lack of agency. In this context, ESD is closely aligned with the United Nations Sustainable Development Goals (SDG), particularly SDG 4 (Quality Education) and SDG 13 (Climate Action). SDG 4.7 explicitly highlights the role of education in equipping learners with the knowledge, skills, values, and attitudes needed to promote sustainable development, while SDG 13 emphasises the importance of improving education, awareness-raising, and human and institutional capacity on climate change mitigation and adaptation. These particular goals underscore the importance of educational approaches that not only inform but also empower learners to act. Thus, central to ESD is enabling learners to act on sustainability challenges, particularly climate change, through mitigation, adaptation, and resilience (UNESCO 2020).

It emphasises that knowledge alone is insufficient to drive meaningful action toward sustainability; instead, it must be integrated with values, attitudes, and skills that foster agency and transformation. A useful model for ESD is found in the work of Jegstad et al. (2018), where they visualise the different layers of knowledge and skills, from "scientific knowledge, via science in context, science distinctiveness and methodological character, ESD competences, and to lived ESD". This model describes the progression from knowledge acquisition to action competence as a core element of holistic sustainability and climate-change education. ESD thus combines cognitive, affective, and psycho-motor learning objectives to nurture not only intellectual understanding but also emotional engagement and embodied practice.

Wellbeing is a fourth dimension of the sustainability compass, introduced in 1999 by Atkisson (cf. Logan and Cutter-Mackenzie 2015). It outlines that teaching natural, social and economic content needs to be taught in parallel with improving knowledge and attitudes on wellbeing. It is important for the future generation to give them hope for the future. When complemented by scientifically grounded information about the issues at hand, this encourages learners to critically reflect on their own role within the realities

that surround them. This is what Orr (2009) means when referring to "realistic hope": hope as a productive starting point – an entry to engagement – rather than a naive reassurance. Recent work further highlights the growing role of ESD in supporting sustainability transitions and higher education curricula (e.g. Leal Filho et al. 2019; Alimehmeti et al. 2024). In this sense, climate change education can be understood as a key domain within ESD, where the development of competencies such as systems thinking, critical reflection, and action-oriented engagement becomes particularly relevant.

Such pedagogical strategies reflect a shift from transmissive to transformative education, in which learners are positioned as active participants capable of envisioning and enacting change. Through participatory learning (Wals 2007) and values education (Tilbury 2011), action competence is cultivated (Mogensen and Schnack 2010), empowering students to reflect critically and engage constructively with complex sustainability issues. This holistic approach recognises that transformative learning emerges not just through content, but through situated, relational, and interdisciplinary practices, anchored in the ethical imperative of sustainability.

Taken above mentioned in consideration, it is suggested that teachers support learners in developing critical thinking skills, working with scientifically verified or verifiable information, and analysing and interpreting data as objectively as possible. It also requires guiding students to critically assess the reliability of information sources and to cultivate an openness to rational, evidence-based discussion. However, climate change learning is not purely cognitive; emotional responses shape how learners engage with and understand climate change (Deisenrieder et al. 2025) and require a highly experienced and sensitive pedagogical approach (Bryan 2020). If left unaddressed, these responses may lead to maladaptive coping strategies such as denial or disengagement (Ojala 2012). In this context, a constructive form of hope becomes crucial, as it supports sustained engagement and is grounded in knowledge, reflection, and agency. At the same time, we need to take into account that we ask students to be informed researchers or citizens in a mediatised culture in which civic engagement develops in increasingly complex, playful ways (Glas et al. 2019). This requires not only a critical understanding of the empirical reality of climate change but also the ways in which this reality is framed and shaped through media and culture.

In the context of students' emotional engagement with complex topics, such as climate change and sustainable development, games and gamification design-based methods have been recognised as effective strategies for strengthening learners' motivation and involvement. Such playful approaches can help introduce complex topics and can provide different perspectives through games' medium-specific procedural and participatory nature (Bogost 2007). In the form of playing serious games, i.e. games used for purposes other than entertainment (e.g. Flood et al. 2018) or through dedicated discursive game design practices (Glas et al. 2021; Werning and van Vught 2021; van Vught and Werning 2024) students can actively simulate, and experiment with, complex real-life situations.

Fieldwork and place-based education emphasise learning through direct engagement with specific local environments, enabling students to situate abstract concepts within real-world geographical, social, and ecological contexts (Gruenewald 2003; Beames et al. 2012). And in this sense, geotechnologies (GIS, online mapping and visualisation tools,

drones) may play a central role, as they enable learners to analyse, visualise, and communicate various geographical aspects, processes, and relationships of climate change, thereby linking abstract global processes to concrete local contexts. When serious-game or discursive game-design activities are connected to such field-based and place-responsive learning settings, they draw on established traditions in geography education and further enhance experiential learning outcomes.

Building on these aforementioned pedagogical foundations, the Shape2Gether (S2G) Erasmus+ project was designed to operationalise these principles within an international and interdisciplinary higher-education context. The Shape2Gether, a unique cooperation of seven universities and a private company, integrates geospatial sciences – such as geography, geoinformatics, and emerging geotechnologies – and adopts a multidisciplinary and holistic perspective to explore the design of an integrated curriculum aiming at the higher education (i.e. university level). This curriculum encompasses not only the scientific understanding of climate processes but also emphasises the development of skills for communicating climate-related knowledge (via game elements and soft skills) to diverse learner groups and the wider public, as climate change is widely recognised as the archetypal "wicked problem," lacking a single, defined solution (CROSS and CONGREVE 2021).

By examining how geospatial sciences, sustainability education, and humanities-based practice-as-research approaches in the form of discursive game design can be meaningfully combined, the project aimed to explore what an interdisciplinary and future-oriented learning framework for climate change education might require in practice. It should be noted that a key outcome of the project will be well-developed learning framework (curriculum), which will serve as preparation for future Erasmus Mundus Joint Master's programmes – though that is not the main focus of this article.

Nevertheless, this newly designed curriculum is geared towards students with a foundational background in geography, geoinformatics, environmental or sustainability studies, education, or related interdisciplinary fields, who are motivated to engage with climate change beyond a single disciplinary perspective. In terms of outcomes, the curriculum aims to develop graduates capable of critically understanding climate-change challenges, applying geotechnological and pedagogical tools, and communicating sustainability issues to diverse audiences. While allowing for individual specialisation, the programme seeks to cultivate active actors operating across science, education, and society.

Thus, the essential learning outcomes of the proposed curriculum is agency. Participants will be supported to take the role of "agents of change": people who work at the intersections of science and society and who are driven to stimulate agency of change in the groups they work with by designing educational activities, engaging in citizen science projects or communicating to general audiences in accessible ways.

This paper gives testimony to how the project integrated and applied these pedagogical strategies to form a curriculum that would transform participants into agents of change, and it is positioned as a conceptually grounded design and implementation study, supported by empirical insights from the project evaluation. The paper thus addresses two interconnected research questions:

- How can ESD-informed pedagogical approaches – integrating discursive game design, place-based teaching, and geotechnology – foster student agency in communicating and addressing climate change and sustainable development?
- What collaborative processes and shared pedagogical practices emerge within a diverse international consortium working towards climate change education, and how these processes can contribute to the design of a joint curriculum?

2 Shape2Gether Narrative

Overview of the Concept and Participants

Shape2Gether is a European Erasmus+ project (from 2023 to 2026) which aims to design a coherent curriculum for future agents of (climate) change using innovative approaches in education for sustainable development. It investigates how these approaches can enhance students' learning and engagement with climate change and sustainable development and support the development of skills associated with becoming agents of change. The project ultimately aims to translate these insights into an international and interdisciplinary educational framework that can guide future curriculum development. To this end, the project to co-create, test, and evaluate pedagogical strategies. Central to this effort is a series of three international summer schools (Norway in May 2024, Malta in October 2024, and Germany in March 2025) that operationalise the project's pedagogical framework in practice.

Shape2Gether brings together is a unique consortium of seven universities – Palacký University Olomouc (Czechia), Ruhr-Universität Bochum (Germany), Utrecht University (The Netherlands), Universita ta Malta (Malta), University of Turku (Finland), Vienna University of Technology (TU Wien) (Austria), Norwegian University of Science and Technology (NTNU, Norway) – and one Finnish private company that works with and develops educational games (Lentävä Liitutaulu – Seppo).The project builds upon existing expertise in geoscience education, ESD, and educational technologies, drawing particularly on experiences gained through earlier international collaborations, in the form of previously funded Erasmus + projects, "EduChange" (Favier et al. 2021; Pánek et al. 2022) and "EduChange 2.0", "Spationomy" (Pászto et al. 2020; Pászto et al. 2021) and "Spationomy" 2.0, and "DigiGeo"). The lessons learned from these projects informed the Shape2Gether summer school curriculum.

Each of the summer schools had their own focus with the collective goal of building the knowledge, attitude and skills of students to become agents of change. Meanwhile, the series of three summer schools allowed students and staff to build meaningful connections and form a community of change agents that would inspire each other and encourage learning together. From each of the participating universities, a minimum of four students could take part, leading to an almost consistent group in all three summer schools (some partners were able to accommodate five students). Participating students had a broad academic background, most of them were enrolled in geography or geoinformatics programs, while others combined subjects from one of the natural science disciplines (physics, chemistry,

biology or integrated natural science) or from pedagogy, social science disciplines or the humanities. Around ten students had backgrounds from more than one discipline.

Pedagogical Approaches

The pedagogical design of Shape2Gether is thus grounded in education for sustainable development (ESD) with additional accents on (1) place-based learning, (2) gamification and discursive game design, (3) challenge-based and active learning, and (4) structured reflection. Together these pedagogical strategies should empower students to become agents of change capable of critically engaging with, responding to, and communicating sustainability and climate-change challenges. While these pedagogical approaches are diverse, they share important common goals. First, they aim to support both cognitive and affective learning and to develop a combination of technical (tool-related) and soft skills. Second, they foster critical thinking and help contextualise sustainability and climate change by linking global challenges to specific local places and by encouraging comparisons across different socio-environmental contexts.

(1) Place-based Learning

Ideas and theory about the value of **fieldwork** and **place-based education** for both ESD and CCE (see e.g. Azevedo et al. 2025) were brought into the programme on two levels: firstly, by bringing all participants together in three different locations for the summer schools and secondly by using various fieldwork pedagogies during those summer schools. Although all this traveling seems counter-intuitive from a sustainability perspective, because of all the carbon emission (e.g. Woodley et al. 2024), the value of being in the field was essential for the development of students in the cognitive, affective and skill domain.

According to France and Haigh (2018) fieldwork offers the opportunities for holistic education and can lead to transformative learning or deep learning (Boyle et al. 2007; Oost et al. 2011, Mercer et al. 2022). Moreover, Israel (2012) demonstrates how fieldwork and place-based education can combine strengths for teaching about pressing social issues. For example, field-based learning in Trondheim summer school (May 2024) enabled experiential connections with ecological systems, while the sessions during the summer school in Malta (October 2024) embedded reflection on sustainability values into real-world socio-environmental tensions. This is attained by:

- **Immersion:** an important element of the programme is direct experience of places and people affected through field work, visiting and exploring sites, interviewing local stakeholders.
- **Hands-on experience:** a second important element of the programme is the learning by doing, students will have to immediately apply their new knowledge on geotechnologies, multimedia and game design, and thus develop skills along the way.
- **Contextualising** climate change and sustainability: visiting different places, and places different from their home, students will experience how climate change has

different impacts on different places, and how local communities respond differently to the challenges.

Fieldwork at these three different locations also allowed for cultural exchange, i.e. visiting different places may spark dialogue and comparison. Where local students and staff act as "interpreters", allowing visiting students to gain a better understanding of local experiences and move beyond stereotyped notions of the place they visit. The exchange of ideas and the mixed background also allow students to discuss and compare their perspectives, notions, and values related to sustainability and climate change. These characteristics illustrate how fieldwork and place-based learning shaped the educational dynamics across the three summer schools. With a strong focus on immersion and hands-on experience, the summer schools also tied in with important dimensions of experiential learning.

(2) Gamification and Discursive Game Design

Game-based learning, gamification, and **discursive game design** were used to engage students in creative, data-informed, and critically reflective learning processes. Gamification refers to the application of game-like elements – such as points, challenges, and feedback loops – into non-game contexts to enhance user engagement, motivation, or learning (Deterding et al. 2011). Discursive Game Design (DGD) treats game-making as a form of critical dialogue, where each prototype is seen as a discursive utterance capable of expressing arguments and perspectives through procedural rhetoric.

In educational contexts, DGD encourages learners to iterate, reframe, and contest meanings through collaborative game creation, promoting reflection on social, historical, or environmental issues. As a form of practice-as-research, it has also been employed in relation to climate change-related projects elsewhere to create so-called "ecogames" (op de Beke et al. 2024; Frelik et al. 2025). A key component of the learning process is understanding that making and playing ecogames requires a critical understanding of how (serious) games themselves function as a media form. Design sessions were therefore bookended by lectures on the topic introducing students to the field of game studies from a humanities perspective.

During the summer school in Bochum (March 2025), the game design process itself became a vehicle for integrating critical thinking, systems thinking, and future-oriented learning – key competencies for sustainable development (Rieckmann 2012; UNESCO 2020). Most of the students had no previous knowledge of how to use game design or game elements within an educational context. DGD as a practice-as-research approach is, however, enables learners with diverse backgrounds and game design literacy to cooperate via a series of exercises (Glas et al. 2021, Werning and van Vught 2021; van Vught and Werning 2024). These exercises, often making use of data gained through fieldwork, were always done in small, interdisciplinary groups, to spark the exchange of experience and ideas among students.

The exercises followed an iterative process of generating, specifying, testing, and evaluating ideas into a playable game. This game would develop through either paper

prototyping making use of a variety of board game components and other materials, or by making use of the digital platform provided by consortium partner Seppo. The use of game design elements in reflection and debriefing allowed for creative and emotional engagement, critical thinking, and embodied understanding of complex sustainability issues through simulated, interactive experiences. By working on a game design, students collaboratively reinterpreted local environmental and societal challenges, transforming them into structured narratives and decision-making frameworks that made abstract sustainability concepts more tangible and personally relevant.

(3) Challenge-Based and Active Learning

A next methodological pillar in the programme is **challenge-based** (see e.g. LEIJON et al. 2021) and **active learning**, which requires students to apply knowledge immediately, solve complex problems collaboratively, and engage with open-ended tasks. Students are provided with challenging and rather open-ended assignments which they cannot solve individually – they thus need to cooperate in multidisciplinary, international teams. These multidisciplinary groups offer plenty of opportunity for peer learning, both in the context of skills (geotechnology, mapping, gamification), education and communication (how to teach about these topics) and content (understanding of climate change, of local landscapes, local sustainability issues).

(4) Structured Reflection

All these pedagogical strategies can contribute to deep learning when **structured reflection** is embedded in the programme to support students in making sense of their experiences, emotions, and learning processes throughout the summer schools (MOON 2013). Elements of the summer schools such as fieldwork, intercultural exchange, and working in interdisciplinary groups can be emotional work for students and moments of reflection are important to make sense of such experiences (BOUD et al. 2013). The programme contained moments of reflection, both on the places and people visited, sustainability, the development of the projects, educational design, and the learning trajectory of each summer school as a whole. This approach helped students to develop important soft skills which they will need to tackle today's wicked problems (SCHÖN 2017). Gamification was used to set reflection in motion too.

In addition to the core methodological pillars described above, the programme also used supporting pedagogical approaches to create a coherent and scaffolded learning trajectory across the three summer schools. The summer schools provided an opportunity for an in-depth exploration of local sustainability issues via flipped-classroom and blended-learning approaches. Prior to each summer school, students were given access to an online lecture and supplementary background materials, ensuring a shared foundational understanding of the key concepts, methodological tools, and characteristics of the host location.

This preparatory phase enabled the on-site programme to begin immediately and proceed at a more advanced level. Moreover, the online pre-meeting served to re-establish

the learning community by bringing participants together several weeks before the start of the summer school. Together, these preparatory components supported the other methodological pillars, enabling students to arrive well-prepared, engage more deeply in on-site activities, and build continuity across the three summer schools.

3 Agents of Change in Shape2Gether

Shape2Gether sees the wicked problems we are currently facing as a collective, collaborative challenge, where international and interdisciplinary teams are essential to move forward and make the changes needed. Agents of change are central to our Shape2Gether approach, as is visualised in the model presented in this chapter (Figure 1). We conceptualise a model for agents of change that touches on all the aspects from the Jegstad et al. (2018) model, and represents an attempt both to adapt these layers to a specific context (climate change) and to build on the strengths of the educational workforce (Hopkins and McKeown 2002), in our case through a broad cross-disciplinary group of teachers and researchers with technological, pedagogical and education for sustainability background.

We understand the agency of change as synonymous with the ability to choose which action to take to make a difference in the world. In other words, agency is seen as the capacity of individuals to act purposefully within specific contexts, shaped by their knowledge, skills, values, and structural conditions (e.g. Biesta and Tedder 2007; Cathcart et al. 2026). At the same time, educators (both teachers and students) position themselves as proactive actors in shaping the design of sustainable development and climate-change adaptation solutions. They also act as promoters of citizen science and cultivate active, responsible citizenship, while ensuring that related scientific knowledge is communicated to the public in an accessible and evidence-based way.

This understanding aligns with ecological perspectives on agency, which conceptualise action as emerging from the dynamic interplay between individuals, available resources, and the social and material contexts in which they operate (Biesta and Tedder 2007). In educational settings, agency is often defined as the capacity to act purposefully and constructively within such conditions (Priestley et al. 2015). Within climate change education specifically, agency has further been linked to empowerment, constructive engagement, and students' ability to respond meaningfully to uncertainty (Ojala 2012). Agents of change facilitating agencies can either be human or things, producing a particular, desired effect on people and the environment. Within this conceptual framing, Shape2Gether distinguishes three interconnected domains of agency that together form the basis of the model presented (Figure 1).

(1) Conceptual Model

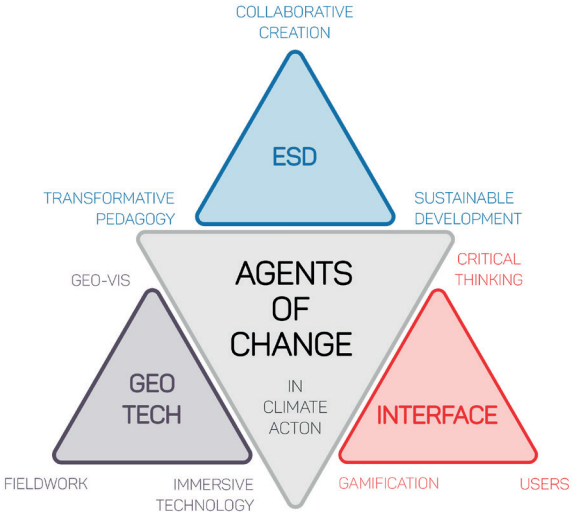
The visual model presented in Figure 1 serves as a conceptual synthesis of the Shape2Gether pedagogical framework, which integrates three primary domains – Education for Sustainable Development (ESD), Geotechnologies (Geo-Tech), and Interface Design – to

cultivate "agents of change" for climate action. At the core of the diagramme lies the notion of agency, which is framed as a dynamic interplay between epistemological, technological, and experiential domains that enable learners to engage critically with sustainability issues.

The tripartite triangular structure reflects a deliberate methodological convergence: (1) ESD emphasises collaborative creation, transformative pedagogy, and sustainable development (UNESCO 2020), (2) Geo-Tech foregrounds fieldwork, immersive technologies, and geo-visualisation as tools for contextual learning (e.g. GERBER and CHUAN 2000; FAVIER and CYVIN 2022; BOS et al. 2022), and (3) Interface components, such as gamification, user interaction, and critical thinking, highlight learner engagement and reflective practice (GEE 2025; ARNAB et al. 2015).

These components build on the methodological pillars introduced earlier, including geotechnologies and geovisualisation (as part of skills development), critical thinking (strengthened through discursive game design), and transformative pedagogical orientations embedded throughout the programme.

The structure aligns with Shape2Gether's mission to address "wicked problems" like climate change through holistic education that cultivates systemic thinking, empathy, and transdisciplinary collaboration (RITTEL and WEBBER 1973; STERLING 2011). Each vertex of the outer triangles encapsulates a domain-specific pedagogical focus that, when enacted through immersive summer school experiences, converges toward the central objective: Shaping empowered learners capable of initiating and supporting sustainable transformations in their communities. The "Agents of Change" positioned in the centre serve both as a goal and a process – emphasising the evolving identity of



Source: Authors. Own Design.

Figure 1: Visual representation of an agency of change

learners as proactive, reflective, and networked contributors to climate resilience and sustainability education.

(2) Actors of Agency in Shape2Gether

Based on this model, three interrelated domains of agency were identified in Shape2Gether: student agency, teacher agency, and technological agency. These categories are not intended as separate elements, but rather as interacting dimensions that jointly support the development and enactment of agency within the learning process.

1 – **Students** becoming active agents of change. The project's aim is to create responsible agents of change that can act as multipliers regarding the transfer of knowledge and reflection on values according to education for sustainable development, be a role model by acting sustainably in everyday life, and foster agency in future generations. Shape2Gether promotes environmental literacy, thus enabling the students to contextualise sustainability and identify local and global challenges and opportunities.
2 – **Teachers** acting as agents of change and broadening their own concept of agency. Teachers in Shape2Gether act as enablers of new ideas and viewpoints, combining knowledge and skill transfer with emotional investment of both students and teachers, thus providing a platform for development and individual growth and group identification.
3 – **Resources and new technologies** acting as agents of change. Through combining climate change topics with geotechnology and serious game design, innovative learning and teaching resources contribute to enhanced systems thinking. Developing and using these resources encourage users to re-think traditional teaching/learning methods, relationships, and concepts. The resources aim at promoting active engagement beyond factual knowledge transfer and include target groups outside usual contexts to raise awareness and facilitate empowerment of a wider audience.

(3) Strengthening Agency through the Summer Schools

During a series of three summer schools, the students' self-perceived ability to act as an agent of change was strengthened by most of the participants, as reflected in the evaluation results, including increased confidence in communication, knowledge gains, and engagement in dissemination activities (Section 4.3). To this end, drawing on both quantitative and qualitative evaluation data (Section 4.3), participants gained content knowledge on sustainability, climate change and related communication; reflected on values; were encouraged to apply critical thinking skills; received training in key technological competencies; and developed various transferable soft skills (such as planning, teamwork, and intercultural communication). Moreover, they formed an interdisciplinary, international supporting network that invites agents of change to find their own voice and discover ways to make changes – using the experiences and new skills learned during the summer schools.

The conceptual model and its three domains of agency also serve as analytical lenses for interpreting the student evaluations presented in the following section. They are also

reflected in the programme design and are further evidenced in the evaluation results, particularly in relation to students' confidence, skills development, and engagement in dissemination activities.

4 Practical Implementation

The methodology and the theoretical framework explained above were elaborated into a 12-month programme which consisted of online preparatory meetings and three international field weeks where students and staff members from each participating university gathered. This chapter provides a concise overview of this practical implementation as it was carried out within the Shape2Gether project. The choice of summer schools' locations reflected the intention to expose participants to a diverse range of natural and socio-economic contexts in which different local manifestations of climate change (e.g. heat-stress and water-management challenges in Malta) and sustainable-development issues (e.g. the transformation of post-mining and industrial landscapes in Germany) could be observed and studied.

From the beginning of the project, the aim was to make deliberate use of the time spent together on site, with a focus on developing practical competencies and employing experiential and place-based learning approaches. Theoretical knowledge and thematic content – both at the overall project level and for each individual summer school – were provided to students through multiple formats: live online preparatory lectures, asynchronous online materials (including recorded sessions available throughout the project), and traditional instructional resources (presentation slides, step-by-step guides, glossaries, recommended literature and others).

To ensure continued engagement after the conclusion of each summer school, students were assigned follow-up tasks depending on the requirements of their home institutions. These included essays or written assignments (e.g. short reflections in case of Utrecht University or diaries in case of University in Turku), and in several cases, ongoing work on bachelor's or master's theses related to the Shape2Gether themes (e.g. in case of Palacký University Olomouc, or NTNU Trondheim). Most importantly, students collaborated remotely in their teams to complete practical project outputs initiated during the summer schools. Each summer school thus resulted in collaborative thematic products (presented further in the text). These three major assignments fostered critical thinking, encouraged students to apply newly acquired skills, work in interdisciplinary and international groups, and improve their time and team management, among other competencies.

4.1 Building Up on Knowledge and Skills and Experiences

All activities designed for students within the project were conceived from the outset to form a coherent sequence and, above all, to cumulatively build on each preceding component (i.e. summer school and its content). What made the project distinctive, particularly from the perspective of the participating students, was that the same cohort from each

institution took part in all teaching and learning activities. Over time, this continuity fostered strong group dynamics and close interpersonal bonds, which proved beneficial for the students' learning processes.

From a pedagogical perspective, the project was intentionally designed to create a cumulative learning trajectory. Each summer school deepened the students' knowledge of the specific thematic focus of that particular event, while simultaneously building on the conceptual and practical competencies developed in the previous stages. Through inter-summer-school assignments and the continuity of the student group, learning appears to have become a gradual, iterative process, in which newly acquired skills were transferred to subsequent tasks, as reflected in the evaluation results and student outputs (see Section 4.3). This enabled students to consolidate their knowledge and apply it in more advanced and thematically demanding contexts during the later summer schools.

The structure of the project embodied a constructed and cumulative learning trajectory, i.e. students moved from acquiring theoretical knowledge, through developing practical skills, to gaining situated experiences in real-world contexts. This approach is generally supported by the concept of scaffolding, where learners' prior knowledge is supported and gradually expanded, providing a suitable lens for understanding this progression (Rojas-Drummond and Mercer 2003). At each summer school and during the preparatory online phase, students engaged with conceptual foundations and deepened their knowledge of the specific thematic focus. The on-site components of the programme then emphasised primarily practical skill development, for example, usage of advanced geotechnologies, fieldwork in sustainability contexts, qualitative research methods, and game design.

Alongside these cognitive and practical dimensions, students also gained situated experiences linked to the specific localities, particularly regarding local manifestations of climate change, and benefited from collaborating in interdisciplinary and international teams. In this sense, students accumulated experiential knowledge – enhancing their understanding of local climate-change issues and their abilities to communicate across cultural and disciplinary divides. These phases reflect the learning cycle of experiential learning (e.g. Kolb 1984) and align with the educational goal of developing knowledge, skills and attitudes for sustainability (Brassler and Sprenger 2021).

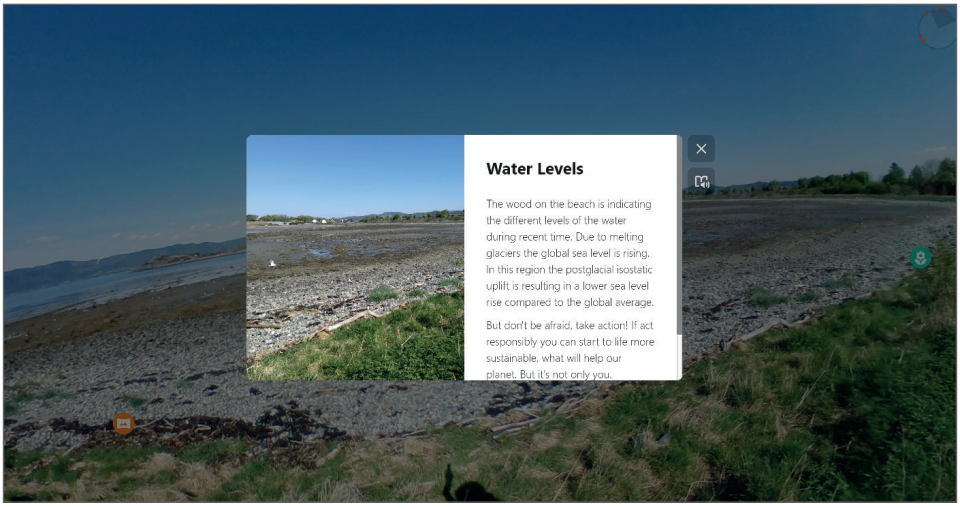
4.2 The Core – Summer Schools

In preparation for each summer school, members of the teaching team developed a range of innovative instructional materials. The creation of these materials was guided by the pedagogical principles underpinning Shape2Gether and included the design of learning activities, assignments, reflection exercises, games, and local fieldwork tasks. In line with the project's commitment to the principles of Open Education, all materials were openly available and organised into structured work packages corresponding to each summer school. Each package was accompanied by a user manual comprising an introduction to the pedagogical approach, a concise literature overview, an explanation of the applied methodology, a description of the teaching and learning techniques, and a brief discussion of the outcomes, including final student outputs and evaluation results.

Besides a day-to-day programme of the summer schools, students engaged in a sequence of team-based assignments, each requiring them to investigate a local sustainability or climate-change issue and communicate it through a concrete output – such as a virtual tour, a multimedia presentation, or a portable game prototype. These assignment types are briefly outlined below to illustrate the practical nature of the project work.

Trondheim Summer School (Norway, May 2024), the first summer school, focused on the "Geo-Tech" vertex of the Shape2Gether triangle, emphasising geosciences, field-based learning, and immersive technologies. Taking place in Tautra and Trondheim, students engaged in place-based education through extensive fieldwork looking at local examples of global climate change, complemented by training in virtual reality (VR) applications for sustainability communication.

Through the use of tools such as "Thinglink" and an ad hoc developed Seppo game, students explored how geotechnology can facilitate deeper engagement with climate change issues in local contexts. Students created a VR-based virtual tour in groups where they were challenged to communicate "the global in the local" and thereby photograph and create a 360-picture photo-story, including elements like interviews, photos, sound recordings, text, links and academic literature tailored towards specific users (Figure 2).



Source: Authors

Figure 2: Preview of the virtual tour (screenshot of a spherical photo-tour with embedded points of interest) of Tautra Island (VR Tour no. 7)

The focus of the "tours" was "the global in the local" at the island Tautra, in Norway, targeted against different audiences: local administrators, master students, elderly tourists, high school students or a delegation of the United Nations Environment Programme (UNEP). The tours were enabling participants to apply immersive and spatial storytelling techniques

in a collaborative environment. Methodologically, the school embraced experiential and constructivist learning, where direct interaction with the environment fostered contextual understanding. Pedagogically, the school incorporated pre- and post-reflection practices and intercultural exchange activities to deepen students' critical awareness. The integration of new technologies also allowed for the development of digital literacies essential for environmental education. As such, Trondheim summer school embodied the Geo-Tech pedagogical strategy within the broader aim of cultivating environmentally literate agents of change.

The second summer school, held in **Gozo and Malta (Malta, October 2024)**, was grounded in the ESD (Education for Sustainable Development) pillar of the Shape2Gether framework. With an emphasis on sustainability literacy, systems thinking, and values education, the programme introduced students to tangible sustainability challenges such as waste management, local food systems, and cultural heritage under climate stress. Activities included site visits, community engagement with local farmers, and a personal sustainability audit, all framed by key ESD concepts.

Students worked in international teams to design educational multimedia projects aimed at raising awareness of sustainability issues with an extensive use of ESRI StoryMaps (Figure 3). In total, students created four products following the logic of the main pillars of sustainability – environmental, social, cultural, and economic. The pedagogical design relied on critical pedagogy, participatory learning, and real-world problem solving, encouraging reflection on the socio-political dimensions of sustainability. Blending cognitive, affective, and behavioural objectives, the Malta school emphasised education as a vehicle for transformation, linking individual agency with collective environmental responsibility.

Source: Authors

Figure 3: Cultural sustainability multi-media project, made by the software StoryMaps (by ESRI) (Group 3)

The **final summer school in Bochum (Germany, March 2025)** centred on the "Interface" aspect of the model, operationalised through the use of gamification and discursive game design. Students were introduced to theoretical and practical elements of serious games and tasked with designing game prototypes addressing regional post-coal transition challenges, defined as the primary thematic focus respectively as the main umbrella theme of the entire summer school.

The programme also included thematic field visits and fieldwork (e.g., to "Zollverein" and "Emschergenossenschaft"), which served as inspiration and research bases for the game concepts. The learning approach combined design thinking, experiential learning, and collaborative prototyping. Methodologically, the summer school encouraged systems thinking and storytelling within the framework of educational games, allowing students to critically reflect on sustainability narratives and power dynamics. Through iterative creation, testing, and reflection phases, the students developed games (Figure 4) that were not only educational but also fostered emotional and social engagement. Thus, Bochum embodied the Interface dimension of the Shape2Gether model, reinforcing how interactive media, game prototypes in particular, can be leveraged for sustainability education.

Source: Authors

Figure 4: Demonstration of game prototype testing (various groups)

During each summer school, students worked in mixed teams to develop a specific product aimed at communicating sustainability issues to a selected target audience through various technological means. The outputs of the project work across the three summer schools were a virtual tour created in "Thinglink" addressing local climate-change impacts on Tautra Island (Norway), a multimedia presentation on local sustainability challenges in Gozo (Malta), and game designs or portable, playable prototypes (card and board games) focusing on local sustainability issues in Bochum (Germany). These group assignments were intentionally open-ended, making them intellectually demanding and design-oriented projects.

The project website provides an overview of these outputs, including virtual field trips, multimedia presentations, and game prototypes, which illustrate the diversity of approaches

developed by student teams. Selected examples are available in the News section of the project website; the direct link is here[1)] (except physical portable game prototypes from Bochum summer school).

To support students throughout the process, several feedback and consultation sessions were integrated into the programme, helping teams refine their design choices and communication strategies. At the end of each summer school, groups presented their final outputs to one another, allowing them to compare different interpretative and communicative approaches to the same overarching challenge. These presentations also opened space for broader discussions, during which the teaching staff reflected on how the students' design decisions aligned with the wider principles of education for sustainable development and climate change education.

4.3 Students' Feedback

At the end of each summer school, students were asked to complete an online evaluation using the "Nettskjema survey tool" provided by NTNU Trondheim (GDPR-compliant). The evaluation followed a mixed–methods approach, combining quantitative Likert-scale items with qualitative responses from open-ended questions. The Likert-scale items focused on the overall organisation of the summer school (with statements about the summer school such as:

> *"* […] *was well organised, provided a coherent structure),"* on core characteristics of the programme *("being in an international group added value",* or *"Tautra was an interesting place to visit"),* and on learning *("my knowledge in local climate change issues increased", "learning to work with Thinglink and 360 images was useful)"*. The open-ended questions focused on overall experiences such as: *"Visiting Tautra was ….", "What were the top three things that you learned during the summer school that inspired you most" or "Which ideas are you going to take home from this summer school to use in your studies, research, and/or teaching?"*

This was complemented by a joint wrap-up session and a weekly evaluation in which students and staff reflected collectively on their experiences. The analysis of these evaluations provided valuable descriptive and exploratory insights into how students perceived and valued key aspects of the project, such as the benefits of working in international and interdisciplinary teams or the experience of being immersed in host locations. The following section is based on the online evaluation.

Overall, students were satisfied with their experience during the three summer schools. On a scale of 1 to 10 they rated the summer schools with an average of 8.6 for Trondheim, 7.6 for Malta and 8.1 for Bochum. Students valued core characteristics of the Erasmus+ programme (see Table 1): its international and interdisciplinary nature. This is reflected

1) *https://storymaps.arcgis.com/stories/3be8795551f74f868e5e0ebd5bd3d40e.*

both in response to the open question where students could rate the top three things they had learned and to two statements on a five-point Likert scale.

As in predecessors of the programme (see e.g. VAN GORP 2022) Shape2Gether students highly valued being in an international group. In the open questions of all three summer schools, students referred to intercultural exchange and community building as important elements of the programme. Participants repeatedly described friendships, cultural immersion, and international collaboration as the most memorable and impactful aspects. In the Trondheim evaluation some even stated they have improved their English language skills.

Their appreciation for the international character is thus very high (4,8 on a Likert scale where 5 equals strongly agree). Students also acknowledged the value of being in an interdisciplinary group (see Table 1). In the Trondheim survey, a student mentioned working in interdisciplinary teams as a benefit, acknowledging *"from how many different fields we can approach the same things."* A student in the Bochum evaluation stated that *"an international and interdisciplinary group can achieve really good things when they can work together"*. However, some answers also indicate that working in such international interdisciplinary groups is not necessarily easy.

	overall	**Trondheim**	**Malta**	**Bochum**
Being in an international group added value	4,8	4,8	4,7	4,8
Being in an interdisciplinary group added value	4,6	4,7	4,6	4,5

Table 1: Students value being in an international and interdisciplinary group (statement on Likert scale from 1 to 5 where 5 represents fully agree).

Students consistently reported knowledge gains across all three summer schools in relation to sustainability, climate change, geotechnologies, and pedagogical approaches introduced throughout the programme. Table 2 shows how students rated the knowledge they acquired during the summer schools. Overall students agree that their knowledge increased – with an overall score of 4 on a 1 to 5 Likert scale. Since the focus of each summer school differed, the exact wording of the evaluation questions varied.

For the sake of comparison over the three summer schools, we have grouped the questions on knowledge gains in three categories. These categories align with the Technological Pedagogical Content Knowledge (TPACK) model by (MISHRA and KOEHLER 2006) and differentiate between content knowledge – which in this case relates to climate change and sustainable development –, knowledge of working with specific technology to create educational / communication products, and knowledge of education for sustainable development – which equals pedagogical content knowledge in the TPACK model.

These three categories were core elements of the Shape2Gether approach and should support the transformation of participants into agents of change. On the part of technological content knowledge, the multimedia presentation offered the least novelty value or new

skillset to the group as a whole and the discursive game design the most. Meanwhile, the presence of a few students with a GIS background amongst the participants may explain why not all students (fully) agreed with the statement that their knowledge about geotechnologies increased even though the "Thinglink" application was new for all of them.

Categories	Statements	Summer school *			
		Trondheim / Taura	Malta	Bochum	Average values
Technological content knowledge	My knowledge in geoscience technology increased	4.13			**4.04**
	My knowledge in designing multimedia resources increased		3.53		
	Ma knowledge in game design for educational purposes increased			4.47	
Content knowledge	My knowledge in local climate change issues increased	3.94			**4.06**
	My understanding of sustainability increased		4.00	3.66	
	My knowledge of local sustainability issues increased		4.40	4.22	
	My knowledge in transformation processes (industrial-natural landscapes) increased			4.13	
Pedagogical content knowledge	My knowledge in education for sustainable development (ESD) increased		3.73		**3.73**
Averaged acquired knowledge		**4.03**	**4.04**	**4.00**	

* Total respondents: Trondheim / Taura: 31; Malta: 31; Bochum: 32

Table 2: Acquired knowledge measured on 1 to 5 Likert scale (value of 5 means that students fully agree with the statement)

In the open questions about the top three things students had learned, the digital tools and technological platforms were also frequently mentioned by students – both in terms of learning new functionalities and understanding how these tools can be applied in educational settings. Regarding the technological skills they for example mentioned:

> *"how to work with Thinglink",* or *"I think it's supercool that I now know the basics of how to create a virtual fieldtrip!",* or *"some new technologies, which were unknown to me but have been developed over the years to become easily accessible*

> *and available to everyone to use (creating and consuming) was great",* and *"how mapping can be used in games".*

Students not only felt they learned to use a new tool, but also how to apply such tools for educational purposes. They for example state that they learned:

> *"how to make games suitable for education (specifically on the Seppo platform). And what elements should those types of games include", "how to work with different kinds of creative technology to present a story",* or *"working on Thinglink and see what is possible to do to avoid 'boring' learning methods and to do it more interactive"*, and appreciated *"tailoring a product towards a specific group and purpose (education, in this case)".*

While we should keep reminding learners that new technologies and tools are solutions in and of themselves, what we saw developing in students was a keen interest in and understanding of the potential – and limitations – of creating new and engaging experiences tailored to specific educational purposes.

Fieldwork was an important element of the Shape2Gether approach. It allowed students to experience new places or how people live in different places. Furthermore, fieldwork served to contextualise climate change. Some students explicitly refer to this in the evaluation. They explain how they have come to gain understanding of local issues

> *"more about sustainability issues in Malta, reflecting on how different aspects of sustainability interact and affect each other, and that these issues have complex solutions"* or *"history and present phenomena in the Ruhr area (regarding land use and employment)".* Some students had a comparative perspective and said, *"how extremely diverse the impacts of climate change are in different parts of the world and following that how diverse and specific the solutions have to be".*

These answers all relate to the contextualisation of climate change and sustainability. Several participants recognised the value of using local issues and creative communication for climate education and

> *"how using local issues and experiences can be very motivating and inspiring to bring the broad climate change issue down to a small and concrete topic."*

Reflection played a continuous role throughout the activities of all three summer schools. It was embedded in daily debriefings, group discussions, and the feedback moments that accompanied project work, culminating into a reflection session during the final presentations. When asked whether they were stimulated to reflect on what they learned, students strongly agreed (4.3) on this for the first summer school in Trondheim where the Seppo game platform was used throughout the week for reflection questions related to fieldwork, location and the assignments. Regarding the Malta and Bochum summer schools,

students reported lower scores (3.6 for Malta and 3.7 for Bochum), which likely reflects the absence of a dedicated digital reflection tool with daily questions. Lastly, some students reported on their personal growth and transformation in the open questions. They commented on having

> *"more faith in what I can do",* or *"don't be scared about presenting and talking to people"* or *"learn to be independent",* and *"challenge myself by doing things that I had never done before."*

The survey after the second (Malta) and third (Germany) summer school included the question whether students felt more confident at communicating climate change (Table 3). The far majority felt more confident, they answered with a clear yes, some even stated, *"definitely yes"* and *"absolutely"*. Others elaborated their answers and explained what it is that they have learned. This could relate to communication skills (presenting in front of an audience, communicating my ideas with others, or communicating it in English), to the content (in particular knowledge of local situations and issues) –

> *"yes, I have a clearer idea of what it is and how to communicate it in a way that stimulates people to do something."* One student identified almost completely with the project goals, saying that *"I gained both technical skills for communication and knowledge about communicating sustainability – and how important it is to include everyone when it comes to sustainability. I also developed the skills to help make the future a better place. That makes me an agent of change."*

Sommer school	Yes	More or less	No	Total
Malta	24	5	0	29
Bochum	24	5	1	30

Table 3: Do you feel more confident communicating climate change

Two students stating that their confidence remained more or less the same, explained how climate change communication is part of their regular curriculum; one student felt that during the summer schools they learned more about the tools to communicate than on the content and another student explained that it is such a broad topic that they only learned about some dimensions. The only participant who mentioned that their confidence did not increase explained that they were experienced: *"been doing this for quite some time already, and it does not get easier"*.

In summary, these reflections show that the programme strengthened students' confidence, communicative competence, and self-perception as emerging agents of change, even while acknowledging that prior experience and disciplinary background shape how individual learners navigate the challenges of climate-change communication. The evaluations give

evidence of how the students started taking their first steps to becoming agents of change. Many of them responded that they would use (some of) the skills learned during the summer school once they would be back home. This was confirmed by the question added to the last evaluation where not only the inclination to apply what they had learned was asked but also if they had already applied knowledge and skills they had learned.

This transfer of learning into practice also set the stage for the students' involvement in dissemination activities, where they continued to apply and expand their emerging agency. Participants had to organise a local dissemination event (workshop, lecture, lesson, game activities, etc.) for a target group of their own choosing to report on their learning outcomes and to inspire others with the prototypes of products such as their Thinglink virtual tour or their game). These ongoing events (December 2025 until May 2026) bring students in the role of agents of change within their home countries. Students have presented the project in a variety of settings: at the educational conference of the Royal Geographers' Association and during the international game research conference *Dutch DiGRA Symposium 2025* (both in The Netherlands), at a public Science Fair event (Czechia), and some are planning to organise special workshops and lectures for children (e.g. Malta).

Taken together, these findings indicate that the pedagogical design of the Shape2Gether programme supports the development of student agency, manifested through increased confidence, applied skills, and active engagement in real-world dissemination activities. These results also highlight how key elements of the programme – such as interdisciplinary collaboration, experiential learning, and structured reflection – can contribute to the development of a joint curriculum by serving as core pedagogical design principles.

5 Discussion and Conclusions

The Shape2Gether project was conceived in response to the need for educational approaches capable of preparing students to address the "wicked" and interdependent challenges of climate change and sustainable development. Such challenges require individuals who possess not only scientific and technological knowledge but also the agency, confidence, and communicative capacity to act as agents of change within their communities and professional environments.

These observations provide the overarching rationale for interpreting the Shape2Gether programme as a response to the educational challenge of preparing future agents of change. In the following sections, we discuss how the project's pedagogical design aligns with this ambition and what lessons emerge from its practical implementation.

Pedagogical Reflections and Evidence from Educational Research

From a pedagogical perspective, the structure of the project tried to embody a semi-scaffolded and cumulative learning trajectory, leading students from theoretical knowledge, through practical skills, to situated real-world experiences (Kolb 1984). Implementation of this framework in higher education – also when supported by digital tools – has been shown to enhance student engagement and deepen learning processes (e.g. Chiu 2019).

Moreover, international exchange and mobility programmes provide a powerful context for converting concrete experiences into transformative learning outcomes (Yang et al. 2021). Empirical evidence further suggests that involvement in hands-on, project-based and research-oriented activities significantly enriches students' experiential learning and their capacity to apply theory in real contexts (van de Water et al. 2024).

The conclusions drawn from our summer school surveys equally support these findings, as each summer school introduced different tools (Thinglink and Virtual Reality, StoryMaps, Seppo platform), but the common thread in students' responses was excitement about new, creative teaching methods. Participants planned and already started to integrate these tools into their own teaching and research. Secondly, each summer school used its local environment as a living classroom. This feature was highly valued, and participants connected strongly to local settings.

The pedagogical design and implementation of Shape2Gether correlates with broader developments in education for sustainable development and experiential pedagogy. Some literature on project-based learning show that engaging students in authentic, problem-oriented tasks fosters the development of their key competences, including interdisciplinary collaboration, critical thinking, and the ability to apply knowledge in real-world contexts (e.g. Bramwell-Lalor et al. 2020). Likewise, studies in environmental and sustainability education confirm that experiential learning approaches – particularly those involving fieldwork, immersion in place, and context-specific inquiry – enhance students' understanding of environmental issues and support deeper cognitive and affective engagement (e.g. Jose et al. 2017; van der Wee et al. 2024). Furthermore, recent findings suggest that combining online preparatory activities with experiential components can amplify students' pro-environmental attitudes and strengthen their capacity to translate learning into action (Douglas et al. 2024).

Having absolved a full cycle of the implemented learning trajectory of the Shape2Gether programme, participants consistently reported becoming more confident, open-minded, and motivated to act as agents of change. Taken together, these insights provide a strong theoretical foundation for the Shape2Gether approach and underscore the value of integrating project-based, experiential, and mobility-based learning to address complex challenges such as climate change and sustainable development.

Geospatial / Scientific Contributions and Identification of the Educational Gap

Looking at it through geographical (or geospatial) lenses, the Shape2Gether project shows the value of integrating spatial thinking, digital (geo)technologies, and place-based experiential learning into a coherent pedagogical framework to promote change agency. Contemporary geography-related programmes commonly address components of these domains – such as spatial analysis, environmental change, or socio-economic transformations – but they do so only partially and often in isolation rather than in an interdisciplinary and comprehensive approach. Based on our review of existing European higher-education programmes (see next section), there is limited evidence of programmes that systematically integrate geotechnologies and advanced technological solutions, sustainability

education (or sustainable development), fieldwork and place-based learning, discursive game design, and communication-oriented competencies, particularly in relation to climate-change adaptation and local sustainability challenges.

Geography and GIS programmes are, by their very nature, frequently linked to topics such as landscape processes, sustainability, and climate change. However, the integration of the third domain addressed in this project – discursive game design and serious games – is absent or not formally included. The activities developed within Shape2Gether illustrate a feasible model of such integration and highlight an educational gap: students rarely have opportunities to engage with real-world sustainability issues through a combination of GIS-based analysis, field-based inquiry, collaborative design work (either working with multimedia or game design), and evidence-based communication. This disciplinary perspective also helps clarify where current higher-education offerings fall short and why new integrated programmes are needed. Therefore, this gap provides a strong rationale for developing a new curriculum that reflects the pedagogical, technological, and thematic innovations trialled in the project.

Implications for Curriculum Development and Future Outlook

Building on the insights derived from the three summer schools, the Shape2Gether project also initiated a systematic review of existing higher-education programmes across Europe to assess the feasibility of a future joint curriculum. The review was conducted using a multi-step methodology that examined accredited programmes at leading European universities across three thematic domains central to Shape2Gether: geotechnologies, sustainability and climate education, and game-based or discursive design approaches.

The analysis revealed a clear structural gap. No existing higher-education programme was found to integrate all three pillars into a coherent curriculum, despite the growing need for interdisciplinary competencies that link spatial thinking, sustainability literacy, and creative communication. A small number of initiatives approached such integration, yet these were predominantly short-term innovation labs or non-formal education projects rather than fully accredited university degrees (e.g. another Erasmus+ project STEAM4Climate).

Programmes combining two pillars – such as geoinformation science with environmental applications, digital-media programmes incorporating gamification, or sustainability education programmes employing playful methods – were identified in greater numbers (e.g. Master in Digital Learning Games at Tallinn University, Estonia; or Master in Sustainable Digitalisation at KTH Royal Institute of Technology, Sweden). However, these dual-pillar models remain disciplinary hybrids rather than genuinely integrated frameworks. Each pillar is strongly represented individually in Europe's educational landscape (e.g. in Sustainable Development at Utrecht University, The Netherlands; Master of Science in Geospatial Technologies at Politecnico di Milano, Italy; or Master in Serious Games at University of Skövde, Sweden), yet their systematic integration remains absent, leaving a conceptual and pedagogical space that Shape2Gether has begun to address.

The competence development targeted in the programme can be understood as a combination of subject-specific and transversal competencies, including sustainability

literacy, geospatial and technological skills, as well as critical thinking, collaboration, and agency, broadly aligning with European competence frameworks. These competencies are operationalised through the integration of pedagogical approaches, learning activities, and evaluation practices described in the programme design. The curriculum development approach is grounded in the identified societal and educational challenges and follows a scaffolded and iterative learning trajectory, integrating multiple domains through a combination of sequential and reinforcing learning activities.

The empirical findings from the summer schools, together with this mapping of the European programme landscape, therefore, provide both a conceptual foundation and evidence-based justification for the development of a new joint curriculum. Such a programme would combine geotechnologies, education for sustainable development, place-based experiential learning, and discursive game design – mirroring the interdisciplinary learning trajectory tested in Shape2Gether. The consortium has now entered the preparatory phase of curriculum design, drawing directly on students' learning outcomes, staff experiences, and the demonstrated gap in current higher-education offerings. The next steps include translating the pedagogical pillars of Shape2Gether into a coherent programme structure and exploring accreditation pathways across partner institutions (e.g. by using Erasmus Mundus Joint Masters scheme).

Beyond these initial steps, several strategic directions will guide the further development of the Shape2Gether curriculum. The project outcomes already provide a strong foundation for a formal joint international programme integrating geotechnologies, sustainability education, and game-based methodologies. Scaling such a programme will require clarifying institutional structures, assessment frameworks, and accreditation pathways across participating universities. In addition, partnerships with schools, municipalities, NGOs, and industry could extend the programme's impact into real-world climate-adaptation ecosystems.

These forward-looking steps illustrate how the project moves beyond a temporary learning intervention and toward establishing a long-term institutional framework for educating future agents of change.

Key Achievements and Limitations

Shape2Gether demonstrates that an international and interdisciplinary learning trajectory can effectively build competencies for climate-change communication and sustainability action. The integration of geotechnologies, field-based learning, and game design created highly engaging learning environments that supported both cognitive and affective learning outcomes. Immersive, place-based learning across geographically diverse contexts strengthened the ability to connect global climate challenges to local socio-environmental realities, enhancing students' systems thinking.

While these achievements demonstrate the project's transformative potential, the implementation process also revealed several important limitations – they exist in respect to organising a sustainable interdisciplinary cooperation (time demanding, expectation management, teacher-to-student ratio). Travel-based programming raised tensions with sustainability principles, highlighting the need for future hybrid models without

compromising place-based pedagogy. Reflection practices varied in perceived depth depending on method and format, suggesting a need for a more consistent reflective framework across all phases. Recognising these limitations is essential not only for improving future iterations of the programme but also for informing the design of a sustainable joint curriculum.

Final Remarks

Overall, the Shape2Gether project demonstrates the potential of a joint, interdisciplinary curriculum that blends geotechnologies, field-based learning, serious games, and sustainability education. It provides a model for how higher education can prepare students to navigate the complexities of climate change with both competence and agency. The cumulative evidence from the summer schools suggests that students not only develop new knowledge and skills but also begin to internalise a mindset oriented toward critical reflection, creative problem-solving, and active contribution to societal transformation. These insights form the foundation for the next phase of the project: the design of an integrated, innovative curriculum capable of educating the next generation of agents of change.

In sum, Shape2Gether provides both a validated pedagogical model and an emerging international community that together lay the groundwork for a new generation of learners capable of acting as agents of change in the face of sustainability and climate challenges.

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