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ORIGINAL ARTICLE

# InterGEO: a Digital Platform for University Education on Geomorphological Heritage

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**Abstract**
The project InterGEO was carried out with the objective to disseminate knowledge on geomorphological heritage by developing a digital learning platform. It aims at improving students' autonomy by the reduction of face-to-face teaching and increasing autonomous learning as well as promoting international interactions between students interested in geomorphological heritage. A completely free-access virtual course on geomorphosites was developed with the Learning Management System Moodle. The course is divided into 24 thematic chapters, each of them containing a short description, a list of references and selected publications, as well as other educational material (videos, virtual fieldtrips, etc.). In particular, several videos allow presenting in a dynamic way concepts and examples. The paper presents the tool and its use in academic programmes in six European universities, where it was tested, in various contexts (Bachelors' and Masters' programmes; students in geography or geology; general courses in geomorphology and specific courses on geoheritage and geoconservation), before discussing the advantages and challenges the tool is facing. The InterGEO platform is an easy-to-use and friendly educational tool, which allows developing blended learning activities; it is flexible and adaptable in various learning contexts.

**Keywords** Geomorphological heritage · Geomorphosites · Education · Interactivity · Moodle

## Introduction

Since the early 1990s, there has been a growing interest for geoheritage and its protection in many parts of the world (Martini 1994; O'Halloran et al. 1994; Sharples 2002; Gray 2004; Reynard and Brilha 2018) and research on geosites has spread rapidly (see Reynard and Brilha 2018 for a review). This has been accompanied by a growing number of courses

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at university level and by the writing of a large number of Ph.D. and Master's theses. For example, the University of Minho (Portugal) has a Master's degree in Geosciences (120 credits according to the European Credit Transfer System (ECTS)), with a specialisation in "Geological Heritage and Conservation" (Brilha et al. 2012); the University of Tasmania (Australia) provides an advanced course on "Landscape Evolution and Geoheritage Conservation" (equivalent 7.5 ECTS); and the University of Lausanne proposes a Master's course on "Geomorphosites and Geoconservation" (3 ECTS). Moreover, advanced courses on geoconservation, geotourism or geoparks are growing, organised by universities, geoparks, geological associations, etc.

In situ geoheritage sites (i.e. geosites, geomorphosites) and ex situ geoheritage material (i.e. collections in museums, "stone gardens") may have a high educational interest as key places where Earth processes and testimonies of the Earth history are well visible and understandable by non-specialised public. For example, mountain geosites are open-air laboratories for environmental education for their high geodiversity, the activity of processes and their sensitivity to climate change (Reynard and Coratza 2016; Bollati et al. 2017a). Also, sites exposed to natural hazards (Coratza and De Waele 2012; Ferrero and Magagna 2015; Bollati et al. 2017b), volcanic sites (Kelley and Salazar 2017), karstic sites (North and van Beynen 2016) and even cliffs equipped for climbing (Bollati et al. 2016) are important landmarks where to promote geological education. Geoparks (UNESCO 2016; Miśkiewicz 2016) and protected areas with geological interest (Serrano and González Trueba 2011; Ilieş et al. 2017) are other privileged places to develop environmental education activities based on geological material. Geoheritage sites are finally key places where universities can organise fieldwork for students (Dillon et al. 2006; Elkins and Elkins 2007; Cayla et al. 2010), and where the issues of geoconservation versus rock or fossil collecting may be discussed (Page 2018).

To improve knowledge, concepts and methods on geomorphological heritage, the International Association of Geomorphologists (IAG) has created a specific working group on geomorphological sites in 2001 (Reynard and Coratza 2013a). The scientific activities of the working group have mainly focused on the definition, assessment and mapping of geomorphosites. An important objective was also to enhance education and dissemination of knowledge on geomorphological heritage towards various public (see Reynard and Coratza 2013a for a review). The university students are one targeted public. The working group has, therefore, organised several intensive courses for Ph.D. and Master's students since 2006 (Table 1). The objective was to focus on specific topics, as methodological aspects (e.g. digital technologies in Evian-les-Bains, France, 2011), geographical areas (e.g. mountain geomorphosites in Lausanne and Hérens Valley, Switzerland, 2013), specific contexts (e.g. geoparks in Lesvos, Greece, 2007) or specific targeted students (e.g. students from developing countries in Beni Mellal, Morocco, 2014, where the course had a great success with 80 participants).

A thematic bibliography (Fontana et al. 2008) and a textbook (Reynard et al. 2009) were also published. The book was aimed at improving the scientific knowledge on geomorphosites, and it targeted in priority Master's and Ph.D. students interested with geomorphological heritage. Based on numerous studies carried out by various researchers in different contexts (academic research, environmental impact assessment, conservation, geotourism), the book proposed a synthesis of the research on geomorphological heritage, both at the conceptual and methodological levels. It was written by 26 authors from 18 universities and 10 countries (Australia, Czech Republic, France, Greece, Italy, Mexico, Poland, Spain, Switzerland, UK), and was organised into four sections: (i) definitions and characteristics of geomorphosites and geodiversity; (ii) assessment and mapping methods; (iii) protection and promotion; (iv) examples of geomorphosite management.

For the period 2013–2017, four objectives were delineated by the working group (Reynard and Coratza 2013b): (i) focus on geomorphosites as key sites for environmental education (to sustainable development or climate change) for various publics (e.g. tourists, school children); (ii) specific activities in developing countries (geomorphosites as tools for local and regional development); (iii) teaching activities for advanced students (MSc/MA, Ph.D.), in particular in developing countries; (iv) development of research on geomorphosites and geodiversity, especially on the assessment of geodiversity, relationships between geoheritage and geodiversity, and application of the concept of geodiversity in geotourism.

University education has rapidly evolved during the last two decades by including digital technologies in teaching activities; this is due in particular to the positive inclination of students towards technology, their high level of ownership and use of technological devices (laptops, tablets, smartphones) and their interest for the use of mobile devices in learning activities (Dahlstrom et al. 2015). Online pedagogy is often based on social constructivism theoretical perspectives (Dougiamas and Taylor 2003). One important change is the reduction of face-to-face lectures and their partial replacement by activities using digital technologies, boosted by the development of the World Wide Web (Khan 1997; Owston 1997). The combination of face-to-face and virtual learning is known as blended learning (Osguthorpe and Graham 2003; Graham 2006) or hybrid learning (Czerkawski and Lyman III 2016), which is a combined mode of teaching at the crossroads of distance education, face-to-face training and information and communication technologies (ICT) (Peraya et al. 2014).

**Table 1** Intensive courses for Ph.D. and Master's students organised by the IAG working group on geomorphosites

| Place | Year | Title | Main focus | No. of students<br>No. of countries |
|---|---|---|---|---|
| Bagnes Valley, Switzerland | 2006 | "Geomorphosites and landscapes" | Definitions and methods of assessment and mapping | 13 students<br>7 countries |
| Lesvos, Greece | 2007 | "Geoparks management and geotourism" | Geotouristic use of geomorphological heritage, in particular within geoparks | 25 students<br>10 countries |
| Lesvos, Greece | 2008 | "Geoconservation and Geoparks: Interpretation and communication" | Interpretation tools to promote geomorphological heritage | 33 students<br>10 countries |
| Braga, Portugal | 2009 | "Geodiversity and geological heritage assessment" | Assessment methodologies applied to geodiversity and geoheritage | 33 students<br>11 countries |
| Evian-les-Bains, France | 2011 | "Using numerical technologies for the assessment and the promotion of geosites" | Numerical technologies applied to geomorphological heritage popularisation | 33 students<br>18 countries |
| Lausanne and Hérens Valley, Switzerland | 2013 | "Mountain geomorphosites" | Specific issues related to geomorphological heritage in mountain areas | 18 students<br>10 countries |
| Aosta Valley, Italy | 2014 | "Geodiversity and geoheritage interpretation" | Interpretation methods to enhance geodiversity and geoheritage | 21 students<br>10 countries |
| Beni Mellal, Morocco | 2014 | "Geomorphosites: definitions and methods of investigation" | Methodological aspects (assessment, mapping, interpretation) | 80 students<br>8 countries |
| Rome, Italy | 2016 | "Methods for the analysis of urban geomorphology and geomorphological heritage" | Methods of investigation for the detection and assessment of urban geomorphosites | 5 students<br>4 countries |

E-learning design should consider four main dimensions (Czerkawski and Lyman III 2016): (i) instructional needs (i.e. students' needs should be assessed); (ii) instructional objectives (i.e. learning goals must be defined and professional standards identified); (iii) learning environment (i.e. interaction and collaboration strategies, design of online material, feedback strategies, types of media, formative assessment and content and task analysis); (iv) summative assessment (i.e. learning outcome assessment and evaluation of formation material and design). Moreover, it is important that students taking online courses receive sufficient technical and academic support (Chen et al. 2010), which means that teachers should transfer the time saved by the use of digital learning tools to supportive activities (feedbacks, workshops, discussions, etc.), as clearly shown by Dahlstrom et al. (2015): students ask for mentoring or face-to-face experiences instead of pure e-learning. In other words, they plebiscite a balance between online and face-to-face work. They also like peer learning and assessment (Boud et al. 1999, 2001), i.e. mutual learning where the students can explain their ideas to others and can participate in activities in which they can learn from their peers.

Quality teaching at university level takes place at three interdependent levels: (i) at the institution-wide level, in particular by internal quality assurance systems; (ii) at the programme level, by assessing and enhancing the design, content and delivery of teaching programmes; (iii) at individual level, by encouraging teachers to innovate and to adopt learner-oriented focus (Hénard and Roseveare 2012). To improve innovation in teaching, the University of Lausanne (Switzerland) has launched a Teaching Innovation Fund (TIF; https://www.unil.ch/fip/fr/home.html, accessed 15.03.2018) in 2012, with two objectives (Berthiaume 2011): (i) helping teachers to develop projects to improve teaching practices; (ii) fostering institutional changes in learning and teaching practices. The TIF consists of a sum of money (up to 25,000€) that the teachers can use to change their teaching practices, and the participants are coached by the Centre for Teaching and Learning (CTL) of the university and by pedagogical engineers (PE; one per faculty). Each project should be permanent and transferable.

The project InterGEO was developed in 2015–2016 within these two contexts: (i) the activities of the IAG Working Group on Geomorphosites for the period 2013–2017, in particular objectives (i) to (iii); (ii) the Teaching Innovative Fund of the University of Lausanne, whose focus in 2015 was to improve the students' autonomy. In this paper, we first present the InterGEO platform, before analysing its implementation in the six partner universities; finally, we discuss the interest of InterGEO in the broader context of university education and dissemination of geoheritage knowledge.

## The Platform InterGEO

The project InterGEO was carried out by six European universities: Bucharest (Romania), Lausanne (Switzerland), Modena

and Reggio Emilia (Italy), Minho (Portugal), Paris-Sorbonne (now Sorbonne-Lettres, Paris) (France) and Savoie Mont Blanc (France). The University of Lausanne was the project's leader. The project had two main objectives: (i) to improve students' autonomy by reducing face-to-face teaching; (ii) to promote international interactions between students.

To achieve these two objectives, a virtual course was developed, using the Learning Management System Moodle (https://moodle.org, accessed 15.03.2018). Moodle is an open-source e-learning platform that allows teachers to provide students with various types of materials (texts, videos, photographs, links to websites, etc.) and to interact with them in real time (Dougiamas and Taylor 2003; Martín-Blas and Serrano-Fernández 2009). It was designed using the PHP language, is easy to navigate in several desktop and mobile devices and may be personalised by the teacher (Dougiamas and Taylor 2003). The system is available worldwide, and currently, there are 96,543 active registered sites from 230 countries (https://moodle.org, accessed 15.03.2018).

The course is divided into four modules and 24 chapters (Table 2). The aim was to cover various conceptual (Module 1), methodological (Module 2) and applied (Modules 3 and 4) aspects of geomorphological heritage. Each learning sequence (chapter) comprises a summary and a text (with key elements, some figures and a small list of key references). Several additional materials are added depending on the topic. There can be videos (Table 2), prepared specifically for this project (Fig. 1), free-access scientific papers, image galleries and case studies. Some lessons are concluded by a quiz that allows the users to test their level of knowledge. All the chapters are written in English, and for some chapters, additional material in other languages is also available. To assess the quality of the documents and to obtain a certain homogeneity between chapters, a system of internal peer-review was adopted.

**Table 2** Structure of the course. x indicates the chapters containing a video content; (x) means that the video is not implemented on the platform at the moment

| Chapter | Module 1—Generalities | Videos? |
|---|---|---|
| 1 | Geomorphosites—Definitions and characteristics | x |
| 2 | Geomorphosites and heritage studies | |
| 3 | Geomorphosites and landscape studies | x |
| 4 | Active geomorphosites | |
| 5 | The working group on Geomorphosites (IAG) | |
| | Module 2—Methods | |
| 6 | The selection and assessment of geomorphosites | |
| 7 | Mapping geomorphosites | x |
| 8 | Geomorphosite visualisation | (x) |
| 9 | 3D in geomorphosite studies | x |
| | Module 3—Conservation and Promotion | |
| 10 | Conservation of geomorphosites | |
| 11 | Geomorphosites and geoparks | (x) |
| 12 | Geomorphosites and World Heritage sites | (x) |
| 13 | Geomorphosite interpretation | |
| 14 | Geomorphosites and geotourism | |
| 15 | Geomorphosites and protected areas | (x) |
| 16 | Geomorphosites and natural hazards | (x) |
| | Module 4—Examples | |
| 17 | Cultural geomorphosites | x |
| 18 | Karstic geomorphosites | x |
| 19 | Coastal geomorphosites | (x) |
| 20 | Mountain geomorphosites | (x) |
| 21 | Fluvial geomorphosites | |
| 22 | Volcanic geomorphosites | |
| 23 | Anthropogenic geomorphosites | |
| 24 | Regional geomorphosites | |

## The Use of InterGEO in the Six Partner Universities

### Improving Students' Autonomy

The InterGEO platform was tested in 2016 in the six partner universities in various contexts (courses of geography or geology; general courses in geomorphology and specific courses on geoheritage and geoconservation; Table 3), both at the Bachelor's and the Master's levels. One main objective was to use the digital platform to improve the students' autonomy by reducing face-to-face teaching and increasing individual learning with computer support. The InterGEO tool was used with various "intensities" (i.e. numbers of hours dedicated to the use of the platform varying from one university to the other) depending on the local context, the implication of teachers and the interaction with other e-learning or blended learning programmes. In some cases, the tool was assessed by the students using typical questionnaires of the respective universities. No systematic and uniform evaluation questionnaire was applied.

### Use of the InterGEO Platform as a Support to Learning

In three partner universities, the platform was used as a tool to support learning, mainly at the Bachelors' level and in courses not specifically focused on geoheritage.

At the *University of Bucharest*, the InterGEO platform was experimented both at the Bachelor's and the Master's levels. It was used during the 2015–2016 "Geomorphosites" course (BA, 3rd year of Geography of Tourism speciality). Considering the large amount of students (nearly 175) and the fact that the platform was in English, 30 volunteers were chosen (with a required medium level of understanding English) to participate in the experimentation. The students used chapters 1, 2, 3, 6, 7, 10, 11, 13 and 14 (Table 2).

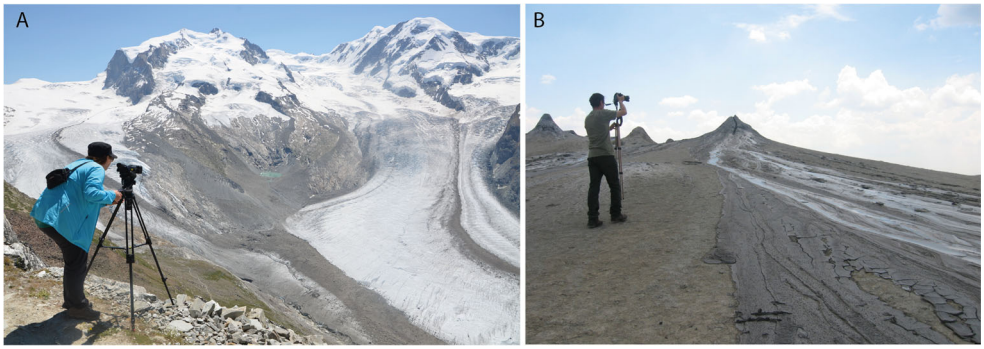


**Fig. 1** Video capture on **a** the Gorner Glacier, Zermatt, Switzerland (photograph by E. Reynard) and **b** mud volcanoes in the Sub-Carpathian Curvature (photograph by F. Grecu)

The students proved receptive to this proposal. The access and login to the platform was considered to be simple and the interface to be user-friendly. As this was their first time using an e-platform, they were very enthusiastic. Based on questionnaires typically used by the faculty to evaluate courses, some students pointed out the strengths of this instrument as being its interactive nature and the modern and actively participative methods that it uses.

InterGEO was also used as a support tool for Master's courses in Process geomorphology (lessons on slope and riverbed dynamics) and for a Bachelors' course on natural hazard mapping (Table 3). The following aspects were treated: (i) the relationships between the relief's dynamics, natural hazards and geomorphosites; (ii) the explanation of the notion of geomorphosites in the case of poorly expressive or short-living sites, such as fluvial geomorphosites (Grecu and Iosif 2016); and (iii) the cartography of vulnerability to hazards of territories that include existing or potential geosites (Grecu and Iosif 2014).

At the *University of Modena and Reggio Emilia*, InterGEO was used as a complement of a general course on Geomorphology for third-year students (about 45) of the Bachelor's degree in Natural Sciences during the fall semester 2016 (Table 3). Chapters on conceptual aspects of geomorphological heritage (Module 1) were used as support to the last part of the course, highlighting the heritage value of the abiotic—and more in particular the geomorphological—features of the environment (Table 2). Two face-to-face lessons respectively introduced and concluded the online course. The first lesson introduced and discussed the state of the art of research in geoheritage in Italy, while the final lesson was organised as a round table where students were invited to discuss the contents of the chapters.

Very often, students in Natural Science degree have a poor knowledge on geological heritage and they often perceive it with a static approach and a museological view. The contents of the virtual course enabled the students to discover and understand the cultural value of geomorphology and underlined how the biotic and abiotic elements should be considered as interrelated and interdependent in a holistic view. The platform was positively evaluated by the students, who mostly appreciated videos. A group of eight students asked to access the chapters of Module 2, witnessing a remarkable interest in geoheritage issue.

At the *University of Paris-Sorbonne*, the InterGEO platform was tested by two groups of students in geography: a first group of seven students during the fall semester 2015, in support of the Master's course "Valuing the natural heritage", then a larger group of 15 students in support of the Bachelor's course on "Natural Heritage" during the spring semester 2016 (Table 3). The test went very well on the technical level and the students were able to connect to the platform without difficulty. Their aim was to work on the natural heritage at the Bachelor's level and on landscape issues at the Master's level; in both cases, they had to use InterGEO to become aware of the diversity of geomorphological features (landforms and processes). Overall, students were interested in this first experience of e-learning, but the teacher's involvement was not strong enough due to lack of time.

## Use of the InterGEO Platform as a Core Tool to Learning

In the three other universities, the platform was used as a core tool to learning, at the Masters' level and generally for courses specifically focused on geoheritage. The case of the University of Lausanne is presented with more details to show how the existing teaching programme was changed to include the use of the digital platform as a core learning tool in the pedagogic scenario.

At the *University of Minho*, the InterGEO project was integrated in the context of the Master's degree in Geosciences—Geological Heritage and Geoconservation (Table 3). This degree has been offered since 2005 with an average of 10 new students each year, being the only post-graduation degree in the world totally dedicated to this domain (Brilha et al. 2012). The InterGEO specific contents on geomorphosites were used to complement the courses/modules "Inventory and characterisation of geological heritage", "Management and promotion of geological heritage" and "Geotourism and geoparks". Normally a specific 2-day workshop covering the aspects of geomorphological heritage was organised each year; during the

**Table 3** Use of the InterGEO platform in the six partner universities. Year is in parentheses (e.g. BA (3) means third year of the Bachelor of Arts programme)

| University | Course (*local language*/English translation) | Curriculum | Level (year) | Number of students | Teacher |
|---|---|---|---|---|---|
| Bucharest, Romania | *Geomorfosituri*/Geomorphosites | Geography of Tourism | BA (3) | 175 (30 volunteers) | Comănescu |
| | *Cartografierea si gestiunea fenomenelor geografice de risc*/Natural hazard mapping and management | Cartography | BA (3) | 60 | Grecu |
| | *Dinamica versantilor*/Slope dynamics | Geography (geomorphology) | MA (1) | 40 | Grecu |
| | *Dinamica albiilor de rau*/The dynamics of riverbeds | Geography (geomorphology) | MA (1) | 40 | Grecu |
| Lausanne, Switzerland | *Géomorphosites et géoconservation*/Geomorphosites and Geoconservation | Geography | MSc (1) | 13 | Reynard |
| Minho, Portugal | *Inventariação e caracterização de património geológico*/Inventory and characterisation of Geological heritage<br>*Gestão e valorização de património geológico*/Management and promotion of geological heritage<br>*Geoturismo e geoparques*/Geotourism and geoparks | Geosciences—Geological heritage and geoconservation | MSc (1) | 8 | Pereira |
| Modena and Reggio Emilia, Italy | *Geomorfologia*/Geomorphology | Natural Sciences | BSc (3) | 45 | Coratza |
| Paris-Sorbonne, France | *Patrimoine naturel*/Natural Heritage | Geography | BA (3) | 15 | Giusti |
| | *Mise en valeur du patrimoine environnemental*/Valuing the natural heritage | Geography | MA (2) | 7 | Giusti |
| Savoie Mont Blanc, France | *Géomorphologie des milieux de montagne*/Mountain Geomorphology | "Mountain" (interdisciplinary) | BA (3) | 15 | Hobléa |
| | *Gestion des espaces et patrimoines naturels*/Management of natural heritage and areas | "Mountain" (interdisciplinary) | MA (2) | 20 (from the two Masters' programmes) | Cayla/Hobléa |
| | *Gestion durable des patrimoines locaux*/Sustainable management of local heritage | Geography and Land Planning | MA (2) | | Hobléa/Cayla |

*BA* Bachelor of Arts, *BSc* Bachelor of Sciences, *MA* Master of Arts, *MSc* Master of Sciences

2015–2016 academic year, the workshop was substituted by a work with the InterGEO platform. Eight Master's students used the platform as a resource to complement the mentioned modules regarding geoheritage conceptualisation, assessment and management. The platform was also made available to three Brazilian Ph.D. students working on geotourism and geoparks in order to complete their knowledge on geomorphological heritage specificities.

The students were asked to assess the platform. Overall, the platform was considered as user-friendly although not so well designed, revealing that it is more based on the contents rather than on its look. It was pointed out that the platform can support a strong e-learning system to disseminate the knowledge on geomorphosites at the university level. It was found that the contents are very well organised and explained, with good examples and very well supported with texts and bibliographic references. The videos were considered as the most powerful tool as they can congregate all the benefits of the high-level e-learning procedures with the specificities of geomorphosites within geoheritage: movement/dynamics; dimension/size; aesthetics.

This experience was also important to support new online courses in the field of geotourism and geoparks, as an efficient way to guarantee quality education for people who are interested in working in geoparks and also to promote lifelong training of geoparks' staff, with the flexibility of studying from anywhere and at any time over the Internet (Brilha et al. 2016).

At the *University Savoie Mont Blanc*, the virtual course on geomorphosites was experimented during the 2015–2016 academic year at two different levels:

(i) It was punctually used as complement of a general course on mountain geomorphology for students in the third year of the interdisciplinary Bachelor's curriculum on Mountain Studies, gathering 15 students in Geosciences, Biology-Ecology and Geography. Chapters 1 (definition) and 18 (karstic geomorphosites) were used for the last lesson, dedicated to applied geomorphology, as an introduction to the topics of geomorphosites and geoheritage. The students were invited to discover online the contents of these chapters by themselves before discussing them during the face-to-face lesson. InterGEO was also a complement to a fieldtrip in the UNESCO Bauges Global Geopark, one of the geomorphosites briefly visited during this fieldtrip being more completely presented in the video of chapter 18.

(ii) The available content of the virtual course was mainly used for blended learning at the Master's level. The virtual course was associated with a pedagogical project supported by two other academic programmes: Promising-IDEFI, a learning-lab carried out by Grenoble-Alps University, that promotes the pedagogy by project (http://www.learninglab-network.com/universite-pierre-mendes-france-grenoble-2-idefi-promising/, accessed March 15, 2018); and LabEx ITEM, a pool of research institutes working on a common programme dedicated to innovation in mountain areas that supports innovative ways of teaching, integrating research-action within mountain territories. The project, entitled "Promoting the invisible heritage of the Bauges Geopark", involved around 20 students of two different Master's curricula (Table 3). Nine students of the Master's programme of Geography and Land Planning participated in a 3-day field workshop in the Bauges Geopark from 26 to 28 October 2015. During the first day, dedicated to the analysis of the territorial needs, students chose to focus their work on the conception and the implementation of a web doc presenting an iconic peatbog to mark the 20th anniversary of its protection. This peatbog (Fig. 2) was considered as a partly invisible geoheritage because (i) the history of its genesis is recorded in its underground component (not visible) that is the key to reconstruct its evolution; and (ii) because the peatbog, covered by snow and ski tracks, is totally invisible during winter (Fig. 2). Students collected field data (videos, interviews) during the two other days of the workshop before processing them during three working sessions ($2 \times 3$ h + $1 \times 6$ h) in November and December 2015, with the assistance of the platform InterGEO. For the geoscientific aspects of the web doc, they were helped by students of another Master's programme ("Mountain" Master's programme, Table 3) who were following an optional module on natural heritage management and who also had a fieldtrip on the peatbog. This web doc, created with the Racontr tool (https://racontr.com/, accessed March 15, 2018), is now available for the geopark and its all-season visitors (only in French language, https://r39da29776.racontr.com/, accessed March 15, 2018).

Masters' students were very motivated by this experiment of applied blended learning. Like their teachers, they were also very surprised by the amount of work that this entailed. The InterGEO project has been the opportunity to involve students and teachers in an e-learning project, which is a key-issue for the University Savoie Mont Blanc. It was the opportunity to initiate collaboration with the new department of e-learning and digital pedagogy of the University. Currently, the team at the University Savoie Mont Blanc continues to develop content for the virtual course on geomorphosites, supported in 2017 by the IDEFI Reflex-Pro that funds videomaking by students and translations. InterGEO will be in the near future used in a new Master's course of Geography entitled "Geosites: Earth as legacy".


**Fig. 2** Field workshop with Master's students of the University of Savoie Mont Blanc (workshop as part of a blended learning experience using the content of the virtual course on geomorphosites available on the platform InterGEO). Different stages of the project leading to the web doc (Photographs by F. Hobléa, N. Cayla)

At the *University of Lausanne*, InterGEO was used as a support for the course "Geomorphosite and Geoconservation" (Master of Sciences in Geography). Until 2016, the course was divided into two parts: 20 h of face-to-face teaching (4 h per day (every morning) during 1 week), and a 3-day field exercise. During the field work, the students were working in small groups and the students' knowledge was assessed by scoring a report produced at the end of the field camp.

InterGEO was used to restructure the first part of the course (Table 4). The number of face-to-face lessons was reduced to seven (instead of 20 in the previous programmes): (i) lessons with a cultural value, to which the presence and the experience of the teacher is important: it is the case of lessons "Research on geoheritage", which gives an introductory overview on current trends of research in the area of geoheritage, and "The heritage value of geomorphology", which is the conclusion of the course that discusses the place of geomorphology in heritage sciences; (ii) methodological lessons, which allow the teacher to insist on certain issues on the use of methods (the three lessons were on specific methods the students were to use for their group works); (iii) specific lessons on geoconservation in Switzerland (InterGEO being an international course, it does not focus on national specificities; the two lessons on the Swiss situation were aimed at completing the content of InterGEO). Six hours of individual and group practical exercises was organised during the teaching time, in class or on the campus, and 1–2 h of homework on the InterGEO platform completed the working tasks every evening. Two quizzes were organised on days 2 and 4 to test the learning outcomes. The second part of the course was a 3-day field camp during which the students applied methods of assessment, mapping and geotouristic promotion of geomorphosites in the UNESCO Bauges Global Geopark (French Alps). Each group delivered a written report and presented its outcomes during a virtual workshop organised with the project partners (see below).

The course was evaluated by the students, which globally appreciated the proposed learning activities (80% of positive comments). The following aspects were assessed positively: well-explained objectives, structure of the course, development of important notions, quality of illustrations, great variability of educational supports, well-explained evaluation modalities, the fact that the course stimulated the reflection, the fact that it was adapted to the preliminary knowledge, the dynamics of the learning activities and the fact that the professor was available for questions. The criteria used for the correction of the works were considered as insufficiently explained. Some repetitions between the core document of each lesson and additional materials (e.g. scientific papers) were noted. Some students appreciated the videos; others considered them as superfluous and redundant, as well as too simple in their content. Finally, there were no comments on the fact

**Table 4** Programme of the course "Geomorphosites and Geoconservation" at the University of Lausanne, spring semester 2016

| Time | Day 1 | Day 2 | Day 3 | Day 4 | Day 5 |
|---|---|---|---|---|---|
| 08:30–09:15 | **Course presentation** | **Group work supervision (by assistants)** | **Face-to-face lesson** ***The assessment method of Lausanne University*** | **Group work supervision (by assistants)** | **Question answering session** (lessons 17–19) |
| 09:15–10:00 | **Face-to-face lesson** ***Research on Geoheritage*** | Virtual lesson 4 Active Geomorphosites<br>Quiz on Lessons 1–5 | **Practical workshop: Geotouristic maps** | Quiz on Lessons 10–14 | **Face-to-face lesson** ***The publics of geotourism*** |
| 10:30–11:15 | Virtual lesson 1 Definitions and characteristics | **Face-to-face lesson** ***Geomorphosite assessment*** | Group work on the University campus | **Practical workshop: Geotouristic maps** | **Face-to-face lesson** ***The heritage value of geomorphology*** |
| 11:15–12:00 | Virtual lesson 2 Geomorphosites and Heritage studies | **Face-to-face lesson** ***Case studies in Switzerland*** | Group work on the University campus | **Face-to-face lesson** ***Geoconservation in Switzerland*** | **Workshop Presentation of group work results** |
| 13:15–14:00 | **Question answering session** (lessons1–2) | | | | |
| 14:00–14:45 | **Group work organisation** | | | | |
| For the following day | Virtual lesson 3 Geomorphosites and Landscape Studies<br>Virtual lesson 5 The working group on Geomorphosites | Virtual lessons 6 to 9 Methods | Virtual lessons 10 to 12 Geoconservation<br>Virtual lessons 13–14 Interpretation and Geotourism | Virtual lesson 17 Cultural Geomorphosites<br>Virtual lesson 18 Karstic Geomorphosites<br>Virtual lesson 19 Mountain Geomorphosites | |

Face-to-face lessons by the professor are highlighted in bold italics; classroom activity (professor or assistants) are highlighted in bold; individual or group works (without the presence of the professor or assistants) appear normal

that the digital content was in English, whereas the official language of the Master's programme was French.

### Enhancing International Exchanges Between Students

One aim of the IAG Working Group on Geomorphosites is to favour the international cooperation in the field of geoheritage studies and to create and maintain a network of scholars working on geoheritage. For this reason, enhancing international exchanges between students was one of the two objectives of the InterGEO project. To facilitate this cooperation at the student level, a virtual workshop was organised on June 13, 2016. Each group of students and their supervisors were located in their own university, and the communication was made by videoconference system. The workshop was organised as a classical scientific conference, with two sessions (Geomorphosites; Geomorphosite management and geotourism), each of them convened by a professor (the first one in Paris, the second one in Modena). Eleven papers (10 min and 5 min for discussion) were presented by groups of students from Bucharest, Lausanne, Minho and Savoie Mont Blanc universities.

This experience was assessed positively by the students. It allowed them to acquire a new competence in presenting their work in the framework of a scientific conference (with the need to be synthetic), in a foreign language and to an unknown audience. Digital tools (videoconference technology) and the small time difference between the involved countries (2 h) allowed an easy-to-organise meeting. However, because the virtual workshop occurred at a period when some students were away from the university, due to professional internships, the students of the University Savoie Mont Blanc prepared a virtual communication using video, presented by their teachers during the workshop.

## Discussion

### Positive Impacts

Several positive impacts of the e-learning platform InterGEO may be listed:

1. The use of the platform contributes to the dissemination of knowledge on geomorphological heritage.
2. It allows the development of online learning tools, which are expected to be further developed in the future to complement conventional lectures in hall in higher education institutions (European Commission 2014). Two digital technologies were used: (i) a virtual course—with various educational materials combining texts, videos, photographs, and scientific articles—was implemented on the e-learning platform Moodle; (ii) a virtual conference was organised by using the videoconference technology. The use of both technologies was assessed positively by the students involved in the programme. In this sense, InterGEO is in line with the general tendency to develop e-learning instruments that meet a need if one considers the appetite for everything that is online for the new generations of students.
3. As a digital tool available on the Internet, InterGEO allows widening knowledge on geomorphological heritage. After the publication of a handbook on geomorphological heritage in 2009 (Reynard et al. 2009), it can be considered as a further step to disseminate knowledge on concepts and methods on geomorphosites. The fact that the platform is fully open-access allows a much better dissemination than the book, whose price (30€)—even not as high in comparison with that of other university textbooks—could be an obstacle for students.
4. It improves collaboration between universities, which is an important element of Europe's strategy for cooperation (European Commission 2014), and which is one of the tasks of the IAG Working Group on Geomorphosites (Reynard and Coratza 2013a, b). The virtual workshop allowed the students of the six universities to communicate with peers in other countries. Nevertheless, if compared with intensive courses (Table 1), during which the students are in contact for 1 week, here the contacts were much less longer and virtual; in this sense, we cannot consider that the collaboration between students of different countries has been really improved. However, at the level of the teaching team, the project has further developed the already present cooperation.
5. Being completely open-access, InterGEO can target other publics than university students, e.g. geopark managers, conservationists, geotourists, etc. However, it is only by analysing web page consultation statistics that conclusions on this question will be drawn.
6. InterGEO was not conceptualised as a massive open online course (MOOC) (i.e. a digital course on geomorphological heritage) but as a digital platform on geomorphosites. This allows a flexible use of the content by the teachers and the students. They do not have to follow a specific order, and they can select which chapters are to be used or not. Also, the content organised in multiple levels of learning (a document that contains the core message of the chapter, further readings (in particular scientific papers), examples and case studies) allows a flexible use of the platform, both at the Bachelors' and the Masters' levels, and even outside of the university context, e.g. in geoparks.
7. The content is user-friendly and videos are considered to be particularly fitted to autonomous learning.

## Challenges

Several challenges may be highlighted:

1. The digital and communication technologies (Moodle platform, videoconference) were used without any difficulty in the six universities involved in the project. The quality of Internet communication was good and allowed a smooth running of the virtual workshop, which could be more difficult to organise with countries where communication tools and computer infrastructure are less developed. Also, a supra-continental cooperation would be more challenging as larger time difference (e.g. for a workshop including students from America, Africa/Europe and Asia) would create coordination problems.
2. E-learning is a new way of teaching, which requires for the teachers a change in habits and a willingness to adapt. It fits with the needs of the new "digital native audience" to which belongs the majority of university students (people born after the development of Internet). The challenge will be to combine "the culture of filming" typical of young generations with "the classical culture of writing" to which the university teachers are generally used to (Tisseron 2012).
3. Another issue is to improve peer learning practices among students and their assessment. The InterGEO experiment only allowed very simple interactions between students, even if experiences in some groups (University Savoie Mont Blanc and University of Minho) allowed using the digital platform as a way to foster peer learning.
4. Language (English) did not seem to be an issue for the students who participated to the experience. Nevertheless, for Bachelor's students, for whom university programmes are often in mother tongue, it could be an obstacle, as was the case in Bucharest, where only selected students with sufficient English skills could participate.
5. The open-access platform raises the copyright issue. Of course, the material produced by the authors is considered to be in the worldwide public domain, and it can be used without any copyright restriction. This concerns the texts written specifically for the platform, as well as the figures and photographs. Concerning the scientific papers, their dissemination depends on the licence rules of the journals in which they have been published. For papers with open-access, we have uploaded directly the PDF file on the Moodle platform. If the access is restricted, we have followed the copyright rules of the journal, and in a few cases, only the reference of papers was included in the platform.
6. One challenge in e-learning practice is the engagement of students and its relationships to successful learning. The following issues are particularly challenging (Czerkawski and Lyman III 2016): (i) academic learning (e.g. capacity to higher order thinking, reflective and integrative learning, development of learning strategies, quantitative reasoning); (ii) learning with peers (collaborative learning); (iii) experiences with faculty (i.e. student-faculty interactions); (iv) campus environment (i.e. quality of interactions, presence of a supportive environment). Currently, the platform InterGEO contains very few tools aiming to enhance students' engagement. Some quizzes are available but they have not been developed systematically for each lesson. InterGEO does not contain any tool intended to facilitate collaborative learning, which is considered to be the task of the teachers. Nevertheless, Moodle allows every teacher to implement his/her proper digital tools, and in a way to customise the course (Singh 2015).
7. InterGEO is not a focused course (for a specific public) nor a MOOC. It is a platform viewed as a supporting pedagogic tool usable in various learning contexts (different academic levels, from undergraduate to postgraduate; various geographical contexts). This is challenging and we have observed that because it does not target a specific group of students, it can dissatisfy several of them. In particular, the videos have been considered as too simple by some Master's students, whereas some participants noticed that the layout—imposed by the Moodle tool—was not very attractive. Nevertheless, it can be viewed as the digital correspondent of a paper textbook for undergraduate students—as was the book published by Reynard et al. (2009)—with the advantage to be fully accessible worldwide and to be easily updated.
8. We have also noticed that not all the partner universities could use the platform in an extensive way simply because the content of InterGEO did not fit with their teaching plan. In particular, it was not easy to coordinate courses scheduled in the fall semester in some universities and in the spring semester in others, nor to fix the date of the virtual workshop.
9. Finally, one challenge is to make the platform evolve in the future. Not only does the content need to be continually updated, but a system of peer-review needs to be adopted to guarantee the quality of contents. Interactions need to be fostered at several levels: (i) between electronic content and face-to-face activities (blended learning); (ii) between participants (peer learning); and (iii) between scientific communities worldwide (one of the main objectives of the IAG Working Groups).

## Conclusions and Perspectives

InterGEO is a digital platform developed on the Moodle e-learning system to disseminate knowledge on geomorphological heritage. It is specifically targeted to undergraduate and

graduate university students but can also be used by other people interested with geoheritage topics. It is composed by a set of 24 learning sequences that can be consulted both in a linear way (from 1 to 24) or independently.

The platform has been tested by the six partner universities in various courses, at the Bachelor's and Master's levels. InterGEO was used both as a support tool to teaching and as a core tool for the development of blended learning strategies. In both cases, the platform demonstrated to be attractive and friendly for students, even if some parts were evaluated as redundant and sometimes too simple (videos).

Three main tasks have to be developed in the future: (i) some lessons are still poorly documented and need to be completed; (ii) as science is continually evolving, a challenge will be to update the content; (iii) finally, some thematic chapters will be added (e.g. a chapter on urban geomorphological heritage, based on recent research development; Pica et al. 2017).

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