The effects of interdisciplinary and international group compositions in student fieldwork

There is much anecdotal evidence of the benefits of fieldwork, but a relatively small amount of research has been carried out on the value of fieldwork for student learning. Existing studies have focused on analysing fieldwork in a mostly disciplinary and national context but the effects of interdisciplinary fieldwork on student learning have not been fully analysed. This paper aims to fill this gap by providing empirical evidence of the impact interdisciplinarity and internationality have on student learning while carrying out fieldwork. The case study consists of three field courses in Portugal in which biology, geography and geology students from Germany and Portugal took part. Based on a group interview with twelve students, their experiences, perceived learning outcomes and overall success of the fieldwork are evaluated. The results support the initial assumptions that interdisciplinary and international fieldwork adds value above and beyond the traditional field experience, and has a positive effect on the learning experience of the students. The students agree they have learned to better define their own study field and the interconnections with other disciplines. They also reported improved (interdisciplinary and intercultural) communication skills and methodological abilities and now feel better prepared to meet academic challenges and careers beyond campus.

Keywords: collaborative student fieldwork; field trips; field course; interdisciplinarity; international field research; field-based learning; evaluation

Introduction

Student fieldwork is an essential part of the curriculum in several disciplines, e. g. in archaeology, biology, geology and geography. In geography the importance of this approach is strongly emphasised, and captured by France and Haigh (2018, p. 498) when they write "Fieldwork is the most powerful learning invitation in the toolkit of Geographical Education". The term "field" is used broadly “to cover any arena or zone within a subject where supervised learning can take place via first-hand experience, outside the constraints of the four-walls classroom setting" (Lonergan & Andresen, 1988, p. 64). Fieldwork can involve a variety of activities in the field. Dando and Wiedel (1971, p. 289) distinguish "(1) field teaching; (2) field trips; (3) field research; and (4) a field camp" whereby these different approaches can overlap. In their definitions they state field teaching introduces novice students to geographical concepts through the study of their local environment and field trips are meant to awaken the students' interest in geography through a regionally and thematically broader investigation and analysis. Field research is mostly conducted by advanced students since it involves a systematic methodology and aims at expanding knowledge or solving relevant geographical problems. Lastly, the authors describe field camps as a combination of the first three categories. This final activity, field camp, comes closest to the field course design discussed in this paper.

While fieldwork continues to have a major place in geography curricula the question has been asked, what is the added value of fieldwork from an empirical point of view for student learning and which criteria are relevant to answer this? When defending the importance of fieldwork for student learning, there has been frequent criticism in the past that there is only anecdotal knowledge about the added value of fieldwork in undergraduate education (e.g. Lonergan & Andresen, 1988; Kent et al., 1997; Boyle et al., 2003; Higgs, 2007). Previous researchers have cast doubt on the effectiveness of fieldwork (Hawley, 1996) due to the didactic/instructive teaching approach with passive student interaction. Indeed, Colby et al. (2003), investigating across a number of disciplines, state that seemingly rich pedagogical experiences can result in shallow learning. In response, several authors have addressed this dilemma (Boyle et al., 2003; Fuller et al., 2003; Fuller, 2006; Rahman & Spafford, 2009; Stokes et al., 2011; Higgs, 2013; Friess et al., 2016). They have analysed experiences with student fieldwork, mainly in disciplinary contexts and with student participants from only one country or even just one university. The potential of fieldwork for learning that exists through international cooperation between staff and students from different universities and also through cooperation between different disciplines, has had less attention. This is unfortunate, as interdisciplinary education (Andrade et al., 2014) and internationalised fieldwork (France & Haigh, 2018) are resource-intensive and could benefit from an evidence base with insights into what works and what doesn't work. Throughout this paper, the term *interdisciplinary* is understood as "a mode of thinking and research that involves the crossing between or among disciplines. This crossing can be done at very diverse scales and levels of integration" (Andrade et al. 2014, p. 3406).

The work of Boyer (1990), Huber and Hutchings (2004) and Klein (2005) among others has stressed the need to help students to make meaningful connections between the disciplines and sub-disciplines they are studying. Klein (2005) says the skills and understanding students will need in the future are not written in any disciplinary textbook. Andrade et al. (2014, p. 3408) argue that the trend towards interdisciplinary education can be seen as a countermovement to a fragmentation of learning. Huber and Hutchings (2004) go further when they urge teachers to build students' capacities for integrative learning, by providing opportunities for connection-making both within and between disciplines, and between campus and the 'real world'. Klein (2005, p. 8) clarifies the relationship between integrative learning, the "umbrella term for structures, strategies and activities that bridge numerous divides" and interdisciplinary studies, a sub-set that "fosters connections between disciplines and interdisciplinary fields" (Klein, 2005, p. 8).

In the present paper, the effects of interdisciplinary and international group compositions in collaborative student fieldwork are explored. In particular, we investigate the possibility that when students are urged to conduct interdisciplinary research, as members of a group, their research is “characterized by unified problem formulation, sharing of methods, and perhaps the creation of new questions” (Record et al., 2016, p. 7).

Our research question is, what is the effect of the involvement of more than just one academic discipline, and a multi-national student group composition, on field-based learning and a student’s achievement of the learning outcomes? Therefore we focus, as a case study, on three two-week field courses carried out in Portugal in August, September and October 2020. One special feature of this case study is that biology, geology and geography undergraduate students from German and Portuguese universities participated in the fieldwork together. Two student cohorts conducted their field courses together in the Algarve, Portugal, while in the third cohort the German participants took part only virtually from their own homes (this course design was triggered by the COVID-19 pandemics, lockdowns and related travel restrictions and will be explained in more detail in the methods section). In each of the three field courses discussed here, the students worked in mixed disciplinary groups. The overall theme of each field course focused on environmental issues of regional importance and empirical relevance.

The insights reported in this paper are based on the analysis of a group interview with twelve German geography students who participated in three distinct interdisciplinary (participants from biology, geography and geology) and international (participants from Germany and Portugal) field courses. We decided to use only the results of the group interview with those participants who study geography, as we are explicitly concerned in this paper with the effects of interdisciplinary and international fieldwork for students of geography. Next, the state of the literature is presented, then the methodological approach is outlined. Subsequently, the results are analysed and finally a conclusion is drawn.

Previous research

In GEES subjects, i.e. geography, Earth and environmental sciences, field trips “remain an integral part of the undergraduate curriculum” (Stokes et al., 2011, p. 198), although the way in which fieldwork is carried out, and the goals to which it aspires, have changed over time (France & Haigh, 2018). According to Higgitt (1996, p. 395), the skills to be taught through geographic fieldwork include intellectual skills ("understanding of geography"), personal skills ("vocational and transferable skills"), technical skills ("methods, use of equipment, etc."), and those skills that are gained simply by staying in the field. France and Haigh (2018, p. 6) emphasise that in recent literature fieldwork is associated with more general “’graduate attributes’ including emotional intelligence, critical thinking, problem solving and global citizenship".

Criticisms of fieldwork include its use as a marketing tool by universities for their degree programmes (France & Haigh, 2018), the ecological impact of travel especially in the context of climate change (Boyle et al., 2003), the high financial costs (Fletcher & Dodds, 2004), the great expenditure of time (Fuller et al., 2003) and the lack of evidence of the didactic benefits of this form of learning and teaching (Kent et al., 1997; Boyle et al., 2003). However, Ritchhart (2002), in his exploration of the nature of thinking and attitudes to learning, makes the case that some students need multiple experiences in meaningful settings to turn their ability into action. Thus, it is important to find out what the students themselves think about the field experiences and what value they attribute to this type of learning.

A number of studies have addressed related questions. Fuller (2006) compared the fieldwork with desk-based teaching by using a student questionnaire and focus group approach applied to two contrasting field trips. The questionnaire was based on twelve categories, which Fuller et al. (2003) developed in an earlier publication (see Table 1).

Category	Definition: responses related to…
1. Experiential	Hands-on experience/visualisation & observation of reality
2. Interest	Stimulation to learn
3. Technical	Use/application of specific equipment and techniques
4. Analytical/research	Data collection and practical skills, sampling & analysis
5. Specific subject knowledge	Understanding of the topic studied
6. Holistic/transferable	Broader issues of learning (beyond the immediate topic), within and beyond degree
7. Assessment/workload	Topic assessment & study workload
8. Financial/resource	Expenses and wider resources
9. Environmental	Being outside/inside
10. Time	Availability of time
11. Teaching/module delivery	Module organisation and teaching issues
12. Social/group dynamic	Cultural and interpersonal behaviour

Table 1: Twelve key categories for educational objectives (Fuller et al., 2003, p. 87)

Based on previous field experiences the results indicated that student perception of fieldwork was predominantly positive. They particularly rate experiencing reality, improving understanding of a topic, learning how to apply equipment and methods, developing holistic and transferable as well as interpersonal skills as key fieldwork strengths (Fuller et al., 2003).

In his paper from 2006, Fuller shows similar results. "Students perceive fieldwork to be beneficial to their learning because through it they experience 'geographical reality', develop subject knowledge, acquire technical and transferable skills and interact socially with lecturers and peers" (Fuller, 2006, p. 215). Here, the term reality refers to the perception of features present in the field in contrast to theoretical knowledge.

In interviews conducted with students by Rahman and Spafford (2009), students stated that field trips improved their problem-solving and group work skills and provided them with “hands-on experience in ways that add value to their everyday experiences, which would be helpful in developing a professional career" (Rahman & Spafford, 2009, para. 13).

Friess et al. (2016) did a questionnaire survey with students, who participated in three different field trips (including a virtual field trip). The questions were constructed with multiple objectives, exploring the reasons for attending (e.g. scientific or social motivation), analysing interactions which could occur between field activities – and ranking the latter in terms of enjoyment – and evaluating “whether the trip provided a deeper, critical, and learning reflective opportunity” (Friess et al., 2016, p. 553). Lastly, students were able to give qualitative comments, e.g. regarding the effectiveness of the trip. Student self-reflection was used to measure the development in deep learning (Friess et al., 2016). The students responded positively to all three activities and in particular noted “a positive increase (either ‘a bit’ or ‘more’) in critical thinking and awareness skills (related to deep learning)" (Friess et al., 2016, p. 555).

Boyle et al. (2003) surveyed 300 geography students who participated in a field course to investigate its potential effects on learning approaches. The results showed that students learned a lot during the fieldwork and rated the group work and the translation of theoretical knowledge into practice as very positive. Students also perceived that their experiences during the field course helped them to cope better with challenges in their academic work, to cope better with physical challenges and to work more confidently with others. Overall, the fieldwork boosted their self-confidence, particularly in relation to future academic challenges (Boyle et al., 2003).

Evaluating the potential of remote fieldwork in a field trip with 41 GEES students, a study by Stokes et al. from 2011 illustrates how remote fieldwork can enhance fieldwork provision. Twenty participants took part in the fieldwork directly and the others remotely from afar. Although both types of fieldwork led to similar learning outcomes, students who had worked directly showed a higher level of enjoyment and interest in the exercise whereas the remote students felt limited in their actions and only passively engaged in the activities (Stokes et al., 2011). More recently, Race et al. (2021) presented evidence on what was lost and what was gained in the conversion to online formats of field courses: while community-building was not supported by online experiences (as compared to in-student field courses), both self-efficacy and connection to the field were reported to gradually gain in online field courses, supporting the conclusions of Stokes et al. (2011).

Overall, the studies summarised in this paper indicate that – based on the perceptions of students and teachers – fieldwork has the potential to have a very positive effect on student learning. The students see a range of possibilities, in relation to what they can learn from their university field trips. Even when field trips are criticised (for example for unequal opportunities or, in the case of travelling by plane, are characterised as being harmful to the environment and climate (Stolz & Feiler 2018, p. 75) the majority of students in the various studies see more of the advantages of these excursions than disadvantages for their education. The key aspects of the value of fieldwork, as indicated in the literature reviewed here, are summed up in Table 2.

While previous studies have examined what value field trips have for the education of students, including field trips abroad (e.g. Dykes et al., 2007) there are few studies that deal specifically with internationality, where students from different countries of origin work together on field trips. In addition, the value of interdisciplinarity is not considered in their analyses. Loynes and Pedersen Gurholt (2017) investigated the experiences of postgraduate students studying landscapes and culture in three European countries and argue that this international experience allowed a deeper appreciation of cultural diversity and increased the students' ability to discuss issues from diverse perspectives. Building on this, Towers and Loynes (2018) conclude that outdoor educators need to develop their own practice and curricula in order to promote internationality. There has been little previous systematic research investigating whether or not an interdisciplinary and international orientation can have any added value for undergraduate student learning.

Table 2: The value of fieldwork: Key results from the reviewed studies (own compilation)

Study	Key Results of the study
1. Fuller et al. (2003)	students experienced reality, developed subject knowledge, acquired technical, transferable and holistic skills, and worked with peers and lecturers
2. Boyle et al. (2003)	students were more positive in: linking challenges in their academic work, being confident in working with others, coping with the physical challenges, and in meeting academic challenges
3. Fuller (2006)	fieldwork provides students with: a better sense of real-world environments and processes, an enhanced understanding of their subject and opportunities for social interaction
4. Rahman & Spafford (2009)	students develop problem-solving skills, enhance constructive social relationships, work in groups and get hands-on experience in ways that add value to their everyday experiences, helpful in developing a professional career
5. Stokes et al. (2011)	On-site fieldwork is an integral part of the undergraduate curriculum in GEES, but remote fieldwork can also enhance fieldwork provision
6. Friess et al. (2016)	students saw a neutral or positive amount of factual information received, a positive increase in critical thinking and awareness skills and a neutral or positive level of enjoyment.

Research Method

The purpose of this paper is to explore the potential impacts of interdisciplinarity and internationality on student groups engaged in fieldwork, on achievement of their learning outcomes and on the field research success – through the eyes of participating (undergraduate) students. A field course was intentionally designed to enable this exploration.

Course design and implementation: The course design was discussed and developed by an international team of educators with disciplinary backgrounds in biology, geology and geography. A backward design approach was used to develop the curriculum whereby the learning outcomes were central. The design of field activities was progressed only after the learning outcomes had been agreed upon. With discussion, it was acknowledged that disciplinary learning outcomes overlapped considerably so that seven key learning outcomes could be agreed upon (see Table 3). Each learning outcome served to encourage interdisciplinary thinking and learning for individual students and student teams, that is they were intentionally created to encourage connection-making. Teaching activities were then designed intentionally to build student capacity for integrative learning. Research-based activity was chosen as it fosters “the sense of excitement that comes from working to answer important questions” (Association of American Colleges & Universities, 2008 p. 1, after Kuh, 2008). It allows scope for critical thinking, creative learning, and outcomes that had not been predicted. The additional high-impact practices encouraged by Huber and Hutchings (2004) and outlined by Kuh (2008) (summarised by Association of American Colleges & Universities, 2008), such as learning communities (facilitated by residential courses), collaborative projects (facilitated by group work), diversity and global learning (facilitated by study abroad), community-based learning (facilitated by contact with local stakeholders) and the concept of fieldwork as a capstone course, drawing together what has been learned before, have all informed the design of this course.

Table 3: *The key learning outcomes of the field trip* (own compilation)

- Work in an international interdisciplinary team to carry out scientific field-based research
- Build on the work of previous scientific investigations by applying a range of relevant in-situ data-collection techniques in a novel field area
- Summarise the relevant interconnected scientific features of a field area by making an illustrated sketch/mindmap/graphic of the important elements of the natural and/or human landscape
- Construct a chronology/succession/cycle of events related to the field area
- Discuss different educational systems and socio-cultural approaches as they exist across Europe
- Interact with industry and/or government and non-government organisations to consider scientific, social and economic aspects of the natural environment in the field area
- Disseminate work, including multiple perspectives, to diverse audiences

After a two-day introduction to the field area, students were assigned to small groups of six students, and each group was tasked with designing and implementing a small field-based research project. Each group consisted of students from three different disciplines and two nationalities. Since none of the German students were fluent in speaking Portuguese, bi-national student groups were a critical aspect of conducting these projects because data collection involved interviews with local people. Each student team had to focus on one topic related to forest management, freshwater resource management or coastal use and protection. Each interdisciplinary team jointly developed a more detailed research question and methodological design according to their individual interests and expertise. During the development of the project ideas, students were supported by the project partners teams through feedback discussions and content-related inputs. In addition to the team members on-site, input and feedback from researchers from the partnering universities were also organised via video conferences. The groups had ten days to collect their data and carry out the preliminary analysis. During this time, the field group leaders supported the students when necessary by providing transport to the field sites, answering questions and establishing connections with local contacts and interview partners. Although experienced field-course leaders were on hand, there was an emphasis on peer learning within each group and between groups. Participants' meetings with representatives of associates from industry and non-governmental organisations brought in relevant expertise and perspectives. The remote participants of the hybrid field course, developed due to COVID-19 were supervised through video conferencing. This included online lectures and discussion sessions. The assessment for all groups included intermediate and final group presentations of research findings, where peer and teacher feedback was received. This allowed students to demonstrate their achievement of the learning outcomes. In order to follow through on the research-based learning, student groups were encouraged to disseminate their results in the form of an article, community presentation, conference presentation, or blog, although this activity was optional. These dissemination activities have multiple functions: 1) They serve to give students experience with different formats of dissemination of results (for academic and non-academic target groups) and 2) The results achieved by the students can be further used – both as a basis for further research and the practical work of the stakeholders in the field. On the one hand, this is motivating for the students, as they see that their work has added value, and on the other hand, it also strengthens the willingness of the local actors to cooperate in further research, as they see that they also receive results from the student research. These dissemination activities also promote student reflexivity (cf. Glass 2014).

While the authors agree that the role of the learner is important, and have intentionally emphasised peer-learning on this course, the scaffolding and dialogue provided by the teachers invited students to engage. The students were allowed to develop the narrative on these courses, as advocated by Bruner (1996) but each group was guided by an expert. The idea of a zone of proximal development as used by Vygotsky (1978) works well in this context, to define the gap between individuals' unaided achievement and their potential achievement with the help of a skilled partner.

Gathering student perceptions: To gain insights into the effect of these interdisciplinary, international field courses on student learning, twelve students from a German university were interviewed in one group interview. All students had previously taken part in one of three joint field courses with Portuguese students. While eight German students were in Portugal in two separate courses (four German participants in each) and worked together with Portuguese students, it was necessary for the third course that four students cooperated remotely (using videoconferencing, messenger services and email) with the Portuguese students (at the field site) due to the travel restrictions imposed during the COVID-19 pandemic.

The group interview was conducted in November 2020 as a video meeting. The fieldwork in which the students participated took place in August, September and October 2020. To structure the group interview, the key results derived from literature on the effects of fieldwork, as shown in Table 2, were presented. The group interview was recorded and later transcribed. The students' responses were evaluated in a qualitative content analysis using the key results from Table 2 as categories for the analysis. Methodologically, no distinction was made in evaluating the answers of the groups of students who travelled to Portugal, and the group that stayed in Germany and took part in remote fieldwork. Since the group interview was conducted in German direct quotes from students in this paper are translated into English.

Results: the students' perceptions

With reference to the key results of Fuller et al. (2003), most students noted that they had experienced geographical features present in the field more clearly than in textbooks, but especially commented on experiencing the comparison with biological and geological conditions and practices. Because of the interdisciplinary course design, students became more aware of distinctive characteristics of their own subject from the other disciplines: "essentially we experienced biological or geological reality but needed to figure out the specific geographical for ourselves. This, I would say, worked because of the project and the [thematic] interlocking in parts quite well" (student 1, fieldwork in Portugal). Being in Portugal contributed to that, since "being on-site was the key factor" (student 1, fieldwork in Portugal). The students who were active together in the field in Portugal not only developed more emotional interpersonal relationships within their interdisciplinary and international teams but also built a more emotional connection to the places of the field research (cf. Simm & Marvell, 2015). This emotional connection to the other students and the fieldwork sites did not develop to the same extent among the remote participants. However, the emotional connection influenced motivation and the enjoyment that the participants had.

The group that had stayed in Germany stated they experienced “less geographical reality than virtual reality” (student 2, remote fieldwork) since they could not experience the fieldwork directly on-site. Also, they felt like working more closely together with the students conducting fieldwork directly in Portugal would have benefitted their learning outcomes since they gained “virtually no new [methodological] knowledge […] because we applied [knowledge] that we had applied before” (student 2, remote fieldwork). While for the on-site students, learning from each other played a central role in the overall fieldwork experience (through international and interdisciplinary teams, but also in joint discussion rounds with the field course leaders), the lack of interaction between the remote students and lecturers and peers resulted in the perception that they only applied their prior knowledge. Consequently, the apparent advantages of interdisciplinary study could not be fully translated through remote fieldwork. The virtual meetings that took place on the one hand within the remote team and on the other hand between the remote team and the teams on-site could not replace the quality of the exchange on site. Although the remote participants also received content-related input via video conference, learning from each other could not take place to the same extent as between the students on-site due to the reduced exchange and especially the lack of informal contact. Still, all students agreed they acquired and developed specific subject knowledge.

All students developed new skills and enhanced already known proficiencies. “All skills we were able to acquire, and experiences we made, can be widely used. Especially new methodological skills” (student 1, fieldwork in Portugal). Again, being on-site, working in an interdisciplinary group, and being able to have a personal interaction with their peers and "living there alone […] with just the peer group" (student 1, fieldwork in Portugal) were key factors in being successfully able to achieve transferable and holistic skills. This can be illustrated by looking at the remote fieldwork group since there was little real knowledge exchange about the project and cooperation between the international students and with the lecturers. The students felt "left out and not included in the whole project" (student 2, remote fieldwork). Here it becomes clear that the low-threshold opportunity for exchange between participants is important for learning from each other. With participants all at one location, these are easy to create, but with a remote course, this is much more difficult.

This corroborates the findings from the study of Stokes et al. (2011) in which it was demonstrated how remote fieldwork could enhance the traditional fieldwork on-site but not as a complete replacement. The remote group of students could not assess the field themselves but had to rely on the other students present on-site to be able to work effectively. Since their collaboration was only loose and in parts difficult, they wished for more opportunities to exchange information. Moreover, they had the feeling of being only seen by the others as "external assistance [...] without [their] own project" (student 2, remote fieldwork). Nevertheless, most students agreed to have gained methodological knowledge and experience in the application of new and already known proficiencies (similar to Stokes et al. 2011).

A unanimous response was given to the second finding of Boyle et al. (2003): all on-site students agreed they are now more positive in linking challenges in their academic work, coping with physical challenges and being more confident in working with others and meeting academic challenges. They emphasised the positive impact interdisciplinarity and internationality had on their project work: "it was extremely positive that we worked in mixed groups […] and that we had to communicate in English" (student 3, fieldwork in Portugal). Not only could the students improve their English communication skills, but they also learned to find good solutions to the field-research challenges despite making compromises. Working with an interdisciplinary group "definitely broadened our horizons because we could support the biologist's and geologist's research" (student 4, fieldwork in Portugal). This was enhanced significantly by being in Portugal since "it was a big advantage being together on-site" (student 3, fieldwork in Portugal). Students learned to work with their own methods and findings, relying only on themselves which made them more confident in the working process. The remote students only partially agreed to the statement of Boyle et al. (2003) due to their problems in collaborating but still confirmed a strengthening of self-confidence to cope with this kind of work.

The special challenges of international and interdisciplinary co-operation in the individual project working groups strengthened the students' project management skills which taught them "important insights [e.g.] that one had to keep the timespan in mind and how to allocate the time best" (student 3, fieldwork in Portugal). The students noted that the joint work contributed to a better understanding and awareness of their own discipline, especially in contrast to other disciplines. They "profited a lot" from "explaining basic [geographical] knowledge" (student 5, fieldwork in Portugal) to students from other disciplines. By delineating the content and skills of their own subject and reflecting their working process and different scientific approaches they were challenged to gain a better awareness and understanding of their own skills and knowledge. The latter corresponds to the key results by Fuller (2006): students obtained an enhanced understanding of the subject and "learned to represent [it]" (student 6, fieldwork in Portugal). They gained an understanding of their subject's possibilities and area of responsibility and learned “to combine the different subjects and to communicate that too” (student 6, fieldwork in Portugal). This can be seen as an important effect of the interdisciplinary fieldwork since Andrade et al. (2014, p. 3412) note that “It is important to begin the process of interdisciplinary collaboration by understanding the borders of one’s own mode of knowledge production, and then understanding how one’s individual approach can be connected and placed in relationship to others.” This effect of self-reflexibility appears to have been more intense in the on-site fieldwork than in the remote fieldwork.

A better sense of real-world environments and processes could also be facilitated by “applying theoretical knowledge to the practical fieldwork” (student 5, fieldwork in Portugal), by working on various issues from different perspectives and by being able to personally interact with others. It “reinforced geographical organisation, fieldwork and understanding for those” (student 5, fieldwork in Portugal) whereby interdisciplinarity and being on-site were key factors in doing so. Even though the remote group missed personal social interaction in the work that they carried out, the “fieldwork still helped [...] to understand the subject better” and offered “a good insight” (student 7, remote fieldwork).

Key factors discovered by Rahman and Spafford (2009) related to establishing a professional career are developing problem-solving skills, enhancing constructive social relationships, group work and hands-on experience which adds value to students’ everyday experiences. During the evaluation process, students confirmed these factors, especially the development of problem-solving skills and those being helpful for prospective professional work. They learned to work independently in support of their group research and “the sense of achievement was especially great because [they] chose the methods [themselves]” (student 8, fieldwork in Portugal). The students “definitely enhanced constructive social relationships and living together […] benefitted [them] all" (student 6, fieldwork in Portugal). Living and spending free time together not only strengthened the emotional connection between the participants (team building) but also created many opportunities for informal exchange and thus learning from each other. For the students, these two weeks of fieldwork were a "great chance […] to apply [in the field] the knowledge [they] had gained throughout their studies" (student 6, fieldwork in Portugal). Furthermore, the possibility to spend time with the whole student group outside of the actual fieldwork offered the students the opportunity to informally process and reflect on the fieldwork, their learning outcomes as well as their personal development. Referring to Friess et al. (2016) who see self-reflection as a key component of deep learning, this reflection process was a crucial part of the on-site fieldwork experience. The social relationships and applied interdisciplinarity were lacking during the work of the remote group but the group members still managed to "develop problem-solving skills because of the many problems which arose" (student 2, remote fieldwork) as well as project and time management skills. This group considered the experience "valuable since [they] learned how hard it can be when things don't go as expected" (student 2, remote fieldwork). Also, the group believed that they will benefit from gained knowledge and insights from this fieldwork for their next project.

Students had further experiences that add value to their everyday lives: It changed their view on different problems, made them critically question aspects in their own lives and made them transfer new perspectives to their life at home: "It was an enriching experience getting to know the region from different [disciplinary and cultural] perspectives" and made them "try to take on a different perspective on a place one already knows quite well" (student 1, fieldwork in Portugal). They agreed that making the experiences in person was a significant part of that process and more important than accumulating theoretical knowledge from afar. It illustrated the environmental and social problems of the region and made them “more tangible than just hearing or reading about it in the news” (student 4, fieldwork in Portugal).

Presented with the findings by Friess et al. (2016) students agreed they received factual information. However, more important for them was the positive development in critical thinking which was “extremely improved by looking at how it really is and by confronting different opinions in conflict” (student 1, fieldwork in Portugal) as well as the improvement in awareness skills. They concluded that working together with students from diverse study fields is a significant learning experience because different opinions and different scientific approaches often arise in an interdisciplinary context. Again, this was supported by being on-site since students not only learnt about new topics but also experienced them in the field which made them feel like they now reflect on issues more critically and evaluate them differently. They all felt positive levels of enjoyment depending on the success of the fieldwork, social interaction and organisational challenges.

Taking all students’ responses into account, it was made clear that interdisciplinarity and international group work had a positive effect on the fieldwork and contributed to the fieldwork’s success. In particular, the fact that students had to define and represent their discipline in interdisciplinary co-operation helped them gain a better understanding and awareness of their own study field: this self-reflexivity definitely indicated merit associated with interdisciplinarity. This significant part of the fieldwork's findings could not have been achieved if the work had included only one discipline. Different academic backgrounds led to heterogeneous skills sets and research interests in each project team. Students also profited from the resulting different perspectives on the same topic and were able to improve their communication skills and intercultural social relationships. The students thought that these skills could have been even more improved if more students with another cultural background had taken part in the project to have a “third point of view” even though already “the difference between locals and foreigners […] was very interesting” (student 9, fieldwork in Portugal). The results of the group of students who participated only remotely were not as positive as the other results but they nevertheless indicated a positive learning effect and experiences.

It was clear that all students had demonstrated achievement of the learning outcomes, though the field-based students were able to demonstrate a higher level of achievement. The student feedback, following the self-directed research carried out by undergraduates on the field course, agrees well with the contention of Ritchhart (2002) that students need immersion in meaningful settings to fully turn their ability into action. The findings from this study align well with previous works that have concluded undergraduate research and problem-based learning should be encouraged as important pedagogies for student learning (Healey and Jenkins, 2009). In particular, Huber and Hutchings (2004) note that undergraduate research and problem-based learning have been shown to facilitate integrative learning. The students in this study showed connection making beyond the interdisciplinary, for example by drawing on a past study to carry out their fieldwork in a novel setting, and by connecting theory to practice in real-world settings.

Conclusion

In light of these results, we have gained insights into the study’s main question, which asked what are the effects that interdisciplinary and internationally-composed student groups can have on student learning and the success of field research. It is important to note that each is an assessment based on student perception and not an actual measurement of learning success. By linking the analysis of the group interview to the theoretical framework, it was made clear that conducting the fieldwork on-site was critical to the level of success but also that the group work with remote participants gained valuable insights into geographical fieldwork.

The insights gained from the group work with remote participants have informed our understanding of what can be done on campus to prepare students for fieldwork and, as Hawley (1996) says, make the most of being on-site.

In general, the overall fieldwork experience did foster the development of subject knowledge, but an important aspect of this was the contribution of interdisciplinarity. Collaboration in interdisciplinary teams – both in the planning and implementation of research projects and in the preparation of dissemination materials – helped students to be more aware of their individual disciplines as they developed a better understanding of their subject-specific skills and knowledge through working with other disciplines. Crucially, interdisciplinarity made the participants look at their study field from a different perspective and critically reflect on it. Even though Fuller et al. (2003) and Fuller (2006) previously determined that student fieldwork leads to the development and better understanding of subject knowledge, the current study is one of the first to reflect on the influence of interdisciplinarity in this process. This aspect was considered very high by the students – and cannot be stressed enough – demonstrating the importance of self-reflexivity by students for learning and specifically their self-positioning as researchers, (see Glass 2014). The lesson to be learned for future fieldwork is that true interdisciplinarity should be encouraged. This means that students should not only work in disciplinary sub-projects that are then joined together, but that they really develop and carry out research projects together and create joint products for dissemination. This requires a high degree of flexibility and openness on the part of the participants and possibly a higher moderation effort on the part of the field course leader, but at the same time increases the learning effect and self-reflexivity.

As in the studies by Fuller et al. (2003) and Fuller (2006) students agreed they acquired technical, transferable and holistic skills. This is in line with the findings of Rahman and Spafford (2009) and Friess et al. (2016) who stated that fieldwork encouraged students to develop problem-solving and awareness skills. The field-based students valued experiencing geographical, biological and geological features and practices in the field and received a better sense of real-world environments. This was not the case for the remote participants. Still, all students confirmed that fieldwork enabled them to work together with peers and lecturers since it afforded opportunities for social interaction. Hereby this study shows how the international team was of particular importance, as it fostered additional intercultural competencies and understanding.

Being able to link challenges in academic work and meeting them with confidence as identified by Boyle et al. (2003) was also part of this fieldwork experience. Students pointed out how choosing and conducting the research methods by themselves and managing the timely and organisational aspects made them more assured in their abilities to carry out academic projects on their own. Moreover, they valued the positive impact of international and interdisciplinary groups on their working progress, as it required them to communicate in English which improved their communication and language skills. Furthermore, it broadened their academic horizons and ability to find good solutions while making compromises between the disciplines through negotiation. Hence, internationality and interdisciplinarity have a significant impact on strengthening the students' abilities in those aspects. These findings are in line with key factors identified by Rahman & Spafford (2009) which state that constructive social relationships are enhanced during fieldwork. These authors also found that students develop problem-solving skills and get hands-on experience, which adds value to their everyday experiences and helps prepare them for a professional career. In this study, the students identified these aspects and emphasised the importance of their experiences and newly developed skills for their future careers. The student group that was working remotely lacked the same level of interdisciplinarity and constructive social relationships since there was less cooperation between the students from different disciplines, but they still evaluated the experience as valuable and instructive. This supports the thesis by Stokes et al. (2011) that remote fieldwork can lead to similar learning outcomes despite different attitudes and perceptions from students. The level of achievement of the learning outcomes however is affected, as evidenced by the responses of students in this study. This study showed how important it is to gain experience personally on-site and not from afar. In particular, the peer-learning was limited for the remote participants because the exchanges via video conference has a lower intensity and, the possibility for informal exchange is missing. It can be deduced from this that in order to use the social, interpersonal element for learning, sufficient time should be given to the opportunities for informal exchange between the participants during the fieldwork and that methods need to be developed for remote fieldwork to promote this informal exchange.

Finally, all students agreed they received a neutral or positive amount of factual information and those who participated on-site enjoyed the field experience (as discovered by Friess et al., 2016) but the latter particularly highlighted their development in critical thinking skills. This was supported by being confronted with different opinions and by being on-site and experiencing new cultures. Consequently, working in an interdisciplinary and international group will add new knowledge and perspectives, and encourage reflexivity to each project. This improves students' academic skills in ways that could not have been achieved in disciplinary group work.

This study has highlighted the added value of international and interdisciplinary field trips as perceived by the student participants. The students themselves acknowledged the benefits and agree that universities should offer and promote such international research to their students. It has also been made clear that interdisciplinarity has a crucial value for geographical field trips. The complexities of the interconnectedness between the disciplines that students identified and needed to communicate and explain were not totally expected but contributed hugely to the overall value of the field research. Insights were gained into how learning outcomes can be partially achieved by focused preparation, on campus, so that student learning when actually in the field can be maximised. With these insights, and particularly in view of the potential barriers to travel (such as pandemic restrictions, inclusion of students with disability, financial cost, and carbon footprint) more consideration is being given to how remote fieldwork can be designed to closer approximate the learning effects and positive experience of on-site fieldwork. These insights have already been used to inform the planning and design of virtual interdisciplinary, international fieldwork that took place in 2021, between German and Irish undergraduate students of Geology, Biology and Geography.

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