Image is everything: Educator awareness of perceived barriers for students with physical disabilities in geoscience degree programs

Abstract

This exploratory pilot study builds on the image issues associated with geoscience degrees (namely physical geography and geology) and the potential obstacles this creates for prospective applicants with physical disabilities; departmental faculty may not be aware of the exclusive image projected that is thought to attract more students. While the industry has moved from field-based data collection to more office-based observation and interpretation of those data, universities still heavily rely on 'adventurous geoscience' in their marketing, depicting students tackling challenging environments. The context of perception issues within the geoscience discipline is illustrated through selected program promotional materials, and student registration data. These issues were used for the basis of our study survey, sent out to higher education geoscience educators, which asked questions reading fieldwork and accessibility of the curriculum. These surveys were followed up with semi-structured interviews, investigating educator awareness of the perceived importance of fieldwork within the curriculum. The awareness of accessibility issues were connected with opportunities to lower perceived barriers sufficiently to encourage students with disabilities to apply for geoscience degrees. Outcomes of this exploratory investigation are hoped to provide the springboard for further conversations amongst the geoscience community.

Keywords: disability, access, inclusion, geoscience

Introduction

Geosciences, which includes popular and widely taught higher education courses such as physical geography and Earth science, appear to portray from an image that inherently excludes

students with disabilities. The geoscience disciplines are often promoted with fit and active practitioners traversing rugged landscapes through unpredictable environmental conditions, which is little consolation for prospective students with physical disabilities. But little is known about the awareness geoscience teaching faculty have regarding the potential barriers students with disabilities might face while pursuing a geoscience degree. This is highlighted through the work of the International Association for Geoscience Diversity (IAGD), a global organization that addresses these barriers when facilitating the participation of students with disabilities in the various geoscience instructional settings (http://www.theiagd.org/). This pilot study investigates possible issues of exclusion through a small-scale pilot study to catalyze a discussion of improving accessibility across the wider geoscience teaching community.

Problem and Context

As briefly outlined in the introduction, the issue investigated here is whether or not geoscience educators are aware of the exclusive culture portrayed by the geosciences, and the extent to which this culture deters the enrollment of students with disabilities. In this study, students with disabilities include any student who experiences difficulties navigating the physical learning environment. This ranges from orthopedic and neurologic impairments that require the use of an assistive device, such as a cane, walker, scooter, prosthetic limb, or wheelchair (Jeannis *et al.*, 2018) to students with visual disabilities (Fichten *et al.*, 2009). If these students are interested in Earth science, but departmental websites only show images of fit and able students and geoscience practitioners, and support these images with descriptions of physical prerequisites, there is little incentive for them to investigate the program further. A basic internet image search of ‘geologist’ (Figure 1) confirms the perception that studying geoscience may only be for able-bodied students.

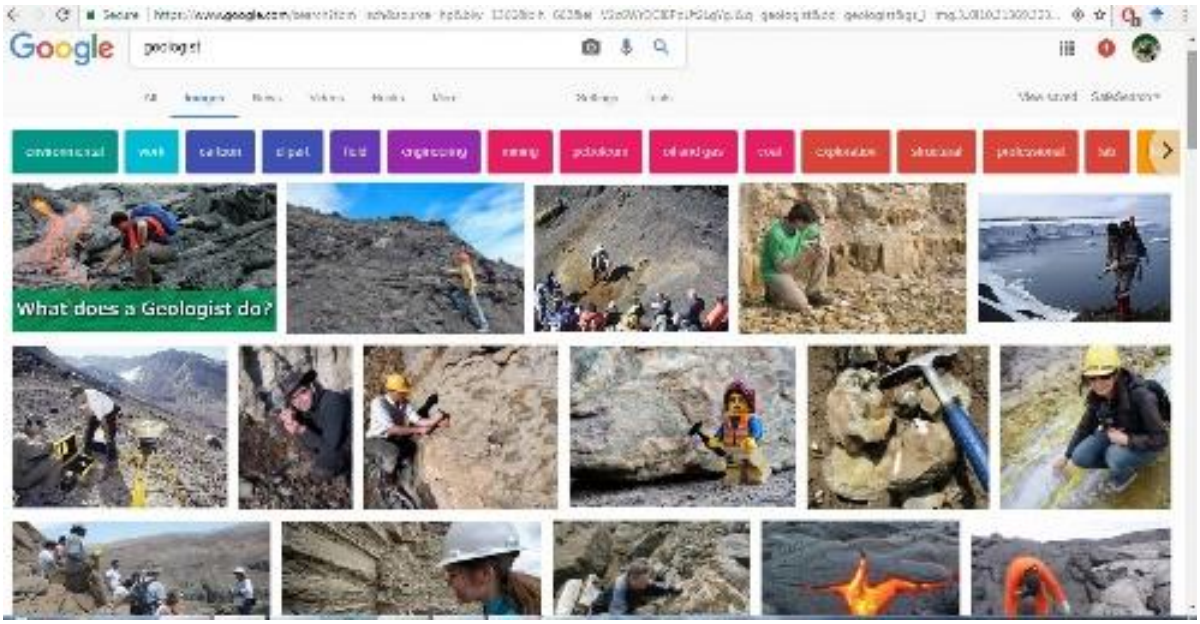

*Figure 1: Top search images for 'geologist' (*Accessed on 20/12/2017 from *Google.com).*

These images provide a starting point for the conversation about the geoscience culture. The key questions asked seek to understand the barriers marketing of a rugged field-based discipline presents for people with disabilities who are potentially interested in pursuing a career in the Earth sciences.

Language used in undergraduate degree promotion

Even though the objectives of fieldwork do not have to require physical ability for success (Atchison and Gilley, 2015; Gilley et al., 2015, Stokes and Atchison, 2015), the underlying expectation is perhaps emphasized in promoting the rugged, field-focused geoscience programs stubbornly present on most undergraduate Geology and Geography websites. The three examples below illustrate promotional language commonly encountered, with key sentences highlighted by the authors.

Oxford Geology: "**Fieldwork is a vital part of an Earth scientist's training**. Our field courses are designed to provide a wide range of practical exercises and field experience in geology and geophysics: observing, measuring, recording, mapping, and problem-solving. Additionally, in the first and second year, our courses prepare students for their own independent mapping projects. For many, the individual mapping is the highlight of their undergraduate career" (Example cited: mapping in Greenland, *Oxford Geology BSc promotional page,* accessed on 20/12/2017 from: *https://www.ox.ac.uk/admissions/undergraduate/courses-listing/earth-sciences-geology?wssl=1*).

Cambridge University: "**What if I'm not the "outdoors type"?** You'll stay in B&Bs, apartments, cottages and even a windmill on one trip; the idea of the course is to learn geology, not "outdoor skills", and for this good rest and good food is a priority. We don't stay in tents, and you absolutely won't be expected to huddle round a primus stove for your dinner! That said, there is ample opportunity for running up mountains, trekking through bracken and swimming in the sea should you so desire" (*Cambridge University BSc promotional page,* accessed on 20/12/2017 from: *http://www-falcon.csx.cam.ac.uk/site/EARTHSCI/teaching/teaching-methods/field-trips*)

Cardiff University's program promotion is somewhat more ambivalent *"A key component of this course is fieldwork. You will travel to a number of classic localities: current field excursions run to areas both in the UK and abroad (Spain and Cyprus). On these excursions you will learn how to record observations, to analyze and interpret a wide range of rocks and structures in the field, and be trained in making a geological map."* (*Cardiff University BSc Geology promotional page, accessed on 04/02/2019 from: https://www.cardiff.ac.uk/study/undergraduate/courses/2019/geology-bsc*) However, while it does not explicitly mention the words 'adventure' or 'terrain' as appeared in many promotional websites, there is no direct indication that these field sites are accessible to all. The overseas field

trips may be perceived to create additional barriers for students, not only for those students with physical disabilities but any students with wider commitments and concerns (i.e. financial, dietary, family care).

These three websites are merely an illustration of the type of language a prospective student receives, and frame the questions used in this study. This language corresponds with the findings of Sexton *et al.* (2014) who concluded that outdoor environments are prevalent on degree scheme websites, and are disproportionately foregrounded with white able-bodied males in promotional images. So why is the broad spectrum of geoscience activities merely limited to the promotion of outdoor exploration through these images?

Representation of the geoscience discipline within the curriculum

The challenge lies in creating a curriculum that enables every student to participate, and communicating that to prospective students without compromising the perceived nature and value of the degree. This problem is particularly prominent in the fieldwork component which is seen as a vital part of the geosciences learning experience (Boyle *et al*, 2007) but often poses the biggest barriers for inclusivity (Hall *et al*, 2002). These issues can be circumvented by choosing accessible field sites over those that require substantial physical effort to visit, as well as incorporating alternative 'field experiences' that are available including: virtual field excursions, video records of field excursions, photographic displays, use of samples collected in situ and core logging (Simpson, 2002). These alternative field experiences can build on data gathered through digital technologies (McCaffrey *et al.,* 2005) and provide a more inclusive environment that still studies the same geological and geographical phenomena (Carabajal *et al*., 2017). Moreover, a prominent use of large data sets and laboratory analysis is can be a more accurate representation of the spectrum of tasks carried out by geoscientists both in academic research and in industry.

In contrast with the image of geoscience as a fieldwork-driven degree presented in the teaching environment of academia, the industry is showing increasingly clear signs of shifting the majority of their work to office-based investigations and reporting, thus needing more graduates trained in the use of data interpretation, computer simulations, GIS and spatial analysis, and quantitative analysis such as advanced statistics (Heath, 2003; Pringle 2015). The focus on field-based studies in undergraduate curricula therefore not only can be perceived as discouraging to students with physical disabilities, but also creates a mismatch between the abilities and skills of potential graduates and the needs of the industry.

This initial overview illustrates that students with disabilities are potentially discouraged at every level from applying to geoscience degrees; their funding has been cut (TUC 2015), the program promotions largely speak to those who are physically able to conduct fieldwork (Sexton *et al*, 2014), and not enough emphasis is placed on the much wider spectrum of geoscience activities that include office-based data interpretation, spatial analysis, and laboratory work as well as virtual and accessible field sites. This pilot study explores why, despite the changing needs of the industry and the discouragement it can create for potential candidates with disabilities, physical field access continue to play a prominent role in the promotion of geoscience degrees. The focus is placed on the attitude of key geoscience educators towards an integrated curriculum that includes all students. Additionally, the potential issues in promoting enhanced access should be evaluated by asking all geoscience educators if they are aware of the image outwardly depicted in geoscience degree programmes, and if there are opportunities for enhancing inclusivity? Geoscience educators are the often the first port of call for prospective students at Open Days and are listed as contact points for enquiries regarding admissions. These educators must be fully aware of the potential issues, and be able to find solutions or alternatives in order to properly advise students as they make the final decision about applying for admission. However, the majority of the research identified in this study is focused on the perspective of those with

disabilities while overlooking the attitudes and perceptions of educators, even though the latter group can be the crucial in alleviating barriers for student participation and encourage higher application rates for geoscience degrees.

Within the academic community there is a wealth of opinion, information and research available describing the difficulties that students with disabilities experience during their studies. This includes the difficulties students encounter when participating in everyday campus life and getting around architectural obstacles (Paul, 2000; Low, 1996; Chard and Couch, 1998), using university facilities (Wilson *et al.*, 2000), participating fully in student life such as extra-curricular sports programs (Pormis *et al.*, 2001) and accessing resources to enable their studies (Borland and James, 1999). However, while students with physical disabilities encounter challenges in any scientific discipline, these are particularly pronounced in the geosciences and result in extremely low participation levels for persons with disabilities. Because of the emphasis placed on field research at the undergraduate level, students with mobility impairments face limited opportunities for progressing in the geosciences (Atchison and Feig, 2011). The available data on the participation of students with disabilities, as presented in the above mentioned studies, shows that participation rates in the geosciences are well below average when compared against other disciplines.

This does not correlate well with UK law, which is quite clear on this issue; “When the UK government ratified the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD), it signed up a commitment to achieve fully inclusive education for all disabled pupils” (TUC 2015, p2). However, sufficient resources need to be available to facilitate this personnel commitment, particularly financial, to adapt laboratories, fieldwork facilities and create new spaces for virtual reality and ample sample storage to ‘bring the field into the laboratory’. This is undermined by the withdrawal of resources, as illustrated by the stark warning of the Trades Union

Congress (TUC):“evidence suggests that progress towards this objective has been patchy, and now, as one of the impacts of austerity, education unions are reporting how it is being jeopardized by a reduction in the resources needed for it to happen” (TUC 2015, p2). As Figure 2 indicates, at first sight the reduction in funding does not seem to have deterred students with disabilities from participating in undergraduate degrees overall. Quite the contrary, the number of students receiving the Disabled Students Allowance (DSA; i.e. government funding to cover some of the extra costs for mental health problem issues, long term illness or any other disability) has climbed steadily year on year and physical science, which includes geosciences, has kept pace with overall student numbers, though the average for physical sciences has steadily changed from above to below average percentage of less able-bodied students in all subjects.

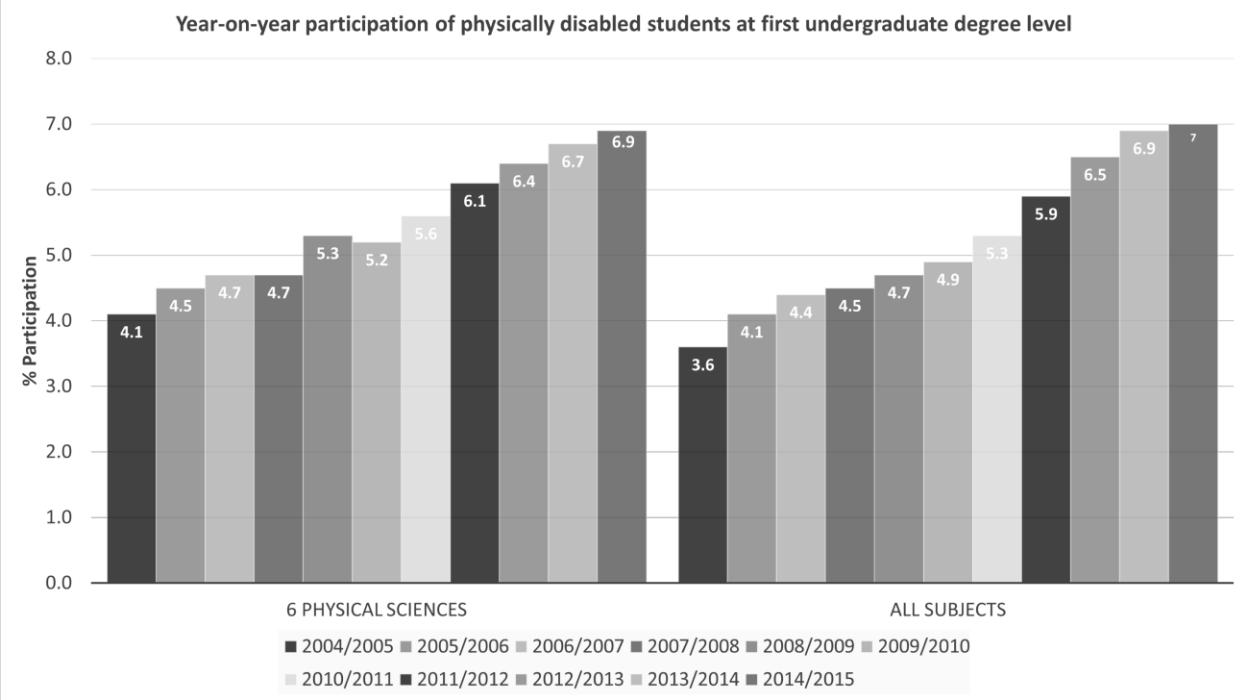

Figure 2: Percentage of undergraduate students in receipt of DSA. Source: Adapted from Equality Challenge Unit data, 2016.

When the data are split out according to discipline the participation of students with disabilities in science and technology is consistently lower than in Social Science and Business degrees (Figure 3). The exceptions are biological sciences and subjects allied to medicine, which actually approach a 10% participation rate for students with disabilities. However, physical sciences (which includes geosciences) struggles to reach a 5% participation rate, half that of subjects allied to medicine and biological sciences, but still more than double that of subjects like architecture (~2%) and mathematical sciences (~2%).

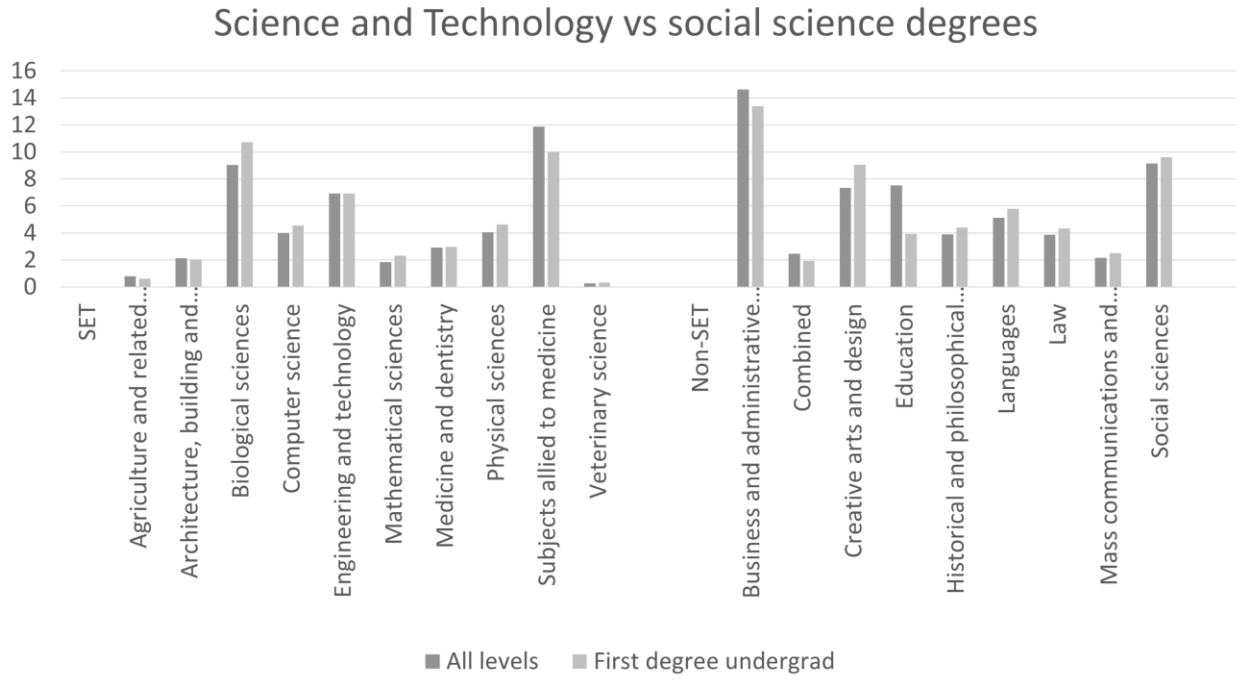

Figure 3: Percentage of students with disabilities per discipline, split out by first degree undergraduate and all levels of study (incl. taught postgraduate). Source: Adapted from Equality Challenge Unit data, 2016.

It should be noted that these data do not differentiate between physical, sensory, or developmental disabilities, and relies on student self-reporting. A further investigation, shown in Figure 4, found that these numbers are dominated by students with learning disabilities (~50%),

and only a small proportion of students report having a physical disability of some kind (~5%), which perhaps do not include non-apparent issues potentially leading to physical disability (i.e. chronic illness, pulmonary conditions). A noticeable trend is the year on year increase in students reporting mental health issues, which is in line with the reported increased prevalence of anxiety and depression among undergraduate students (Ibrahim *et al.*, 2013). The issue is difficult to assess solely on statistics; the numbers are distorted through the bundling together of disability categories as well as the absence of data for geoscience in particular. Even though, according to the numbers, the participation of students with disabilities is on the rise, these students remain noticeably absent from the classroom.

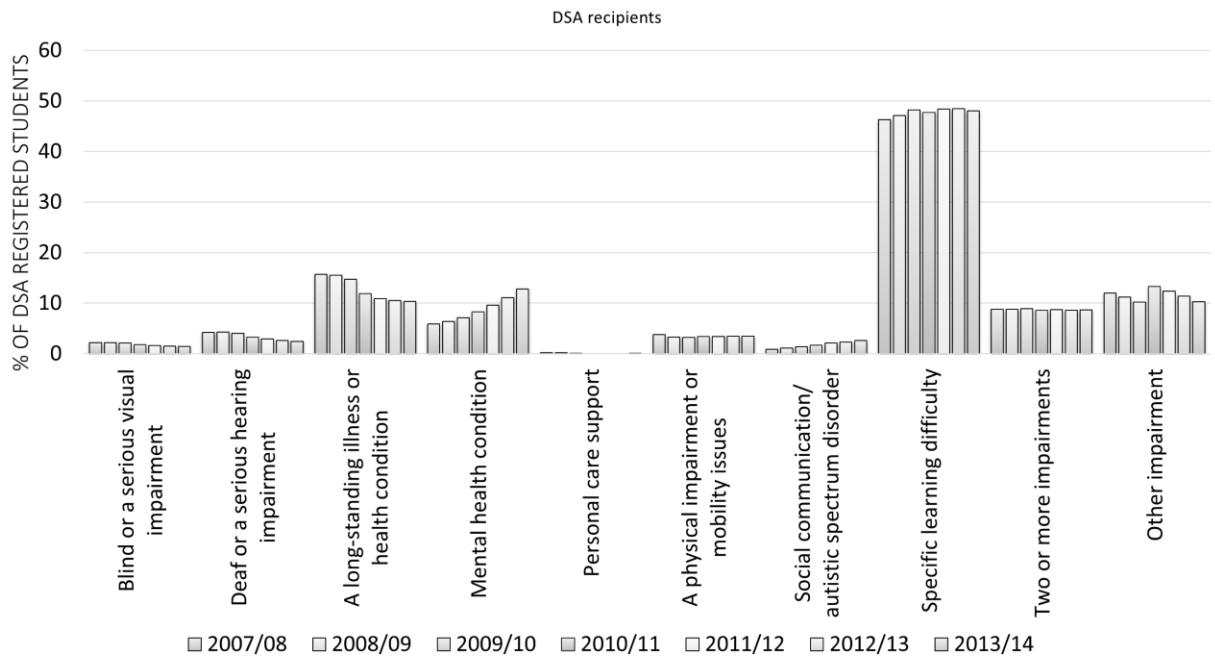

Figure 4: Percentage of DSA registered students split by type of disability. Source: Adapted from Equality Challenge Unit data, 2016

Wider loss of support for students with disabilities

By law, ‘reasonable adjustments’ need to be made for employees and students with disabilities (UK Equality Act 2010) but in 2014 the UK government announced major changes to the DSA to cut funding for equipment and support and passed responsibility onto universities. This has created a substantial potential impact on students themselves, as well as penalizing institutions that had done most to encourage applications from people with disabilities (TUC, 2015). In addition, as Borland and James (1999) state “unlike the long-standing debate over mainstreaming within the school system, higher education has largely remained untroubled by the requirement to provide higher education for people with disabilities” (p.86). In disciplines which rely heavily on fieldwork to attract students into their lecture halls, this lack of structured enforcement of support for students with disabilities adds to a continued myth that to succeed in geoscience you need to be able to scale slopes and hike across uneven ground to fulfil this widely touted field component. Fieldwork is an increasingly used strategy for integrated learning in the area of geosciences in high school (de Barros *et al.*, 2012), which only bolsters the pre-university student perception that field activities are an absolute necessity. In combination with the aforementioned cuts to DSA and institutional support, this makes the geosciences an even more prohibitive field for students with physical disabilities, as is reflected in the participation rate noted by Burrelli (2004).

Potential loss of talent and skills in Geoscience

The language used encourages a great loss of potential. Atchison and Librarkin (2014) report that “people with disabilities are viewed as viable professionals once in the geosciences, but the pathways into the discipline are prohibitive” (ED31I-01). An earlier study by Burrelli (2004) into the representation of persons with disabilities in science and engineering reported that geoscientists with disabilities make up a very small proportion of doctorate recipients and employed geoscientists; little more than 2% of geoscience doctorate recipients in 2001 reported a disability. Persons with disabilities constituted 7% of all employed geoscientists in 1999 and 5% of employed geoscientists with doctoral degrees in 2001. Therefore, the recruitment problems of

students with disabilities into undergraduate degrees will undoubtedly yield consistent under-representation at graduate and professional levels.

Statement of the Problem and Research Questions

As outlined above, promotional geoscience narratives are potentially discouraging students with disabilities from pursuing a career in these disciplines. This is particularly reflected in the low participation rates of students with disabilities in higher education, as previously discussed, which are perhaps also reflected in the lack of employed professionals with disabilities in the geoscience workforce. But are geoscience educators aware that the promotional language used in the curriculum can be turning these students away? This is particularly poignant in the prevalence of fieldwork in the curriculum and its prominent place in promotional approaches for degree schemes. This leads to the following questions that will be addressed through this exploratory pilot study:

1. To what extent are geoscience educators aware that the promotional language used may discourage participation of students with disabilities?
2. To what extent are geoscience educators aware that the prevalence of fieldwork in the curriculum might pose barriers to students with disabilities?
3. How are geoscience educators actively working to mitigate exclusive practices?
4. To what level do geoscience educators and university support staff work effectively together to mitigate exclusive practices?

Methods

As the TUC statistics presented in the introduction were inconclusive regarding the performance of geoscience as an accessible degree choice, the authors feel it necessary to take a different approach to mapping the potential barriers presented by the traditional geoscience image. The

approach offered by this exploratory pilot study uses extended response survey questions and unstructured interviews with key academic stakeholders in the geosciences.

Study population

Geoscience Educators

Only geoscience educators were approached for information regarding student access and participation. A survey calling for voluntary participation was sent to educators via electronic mail and personal requests, followed by a call distributed through social media (twitter) and electronic mailing lists. A total of seven respondents completed the email survey, which were followed up with interviews. These respondents were drawn from UK universities. To comply with data protection and research ethics all names have been replaced by their position. The call to social media and mailing lists yielded an additional 51 completed surveys, which were not restricted to a geographical area. Of the respondents, eight provided details on their current employment. 62.50% (n=5) hold a senior education post (senior lecturer, associate professor, professor), 37.50% (n=3) hold a junior education post (assistant/adjunct professor, lecturer) and none preferred not to identify. No technical support staff or administrative staff were identified in this survey, although 43 of the 51 respondents chose not to answer this question. This bypasses the actual student target group, for a more in-depth study these students should be asked directly what obstacles they encountered or perceived when either considering studying the geosciences or completing a degree. This issue was previously noted by Oliver (1996) who observes that research regarding people with disabilities that fails to engage with them directly risks alienating them from the research project. While research should engage with the target group, this study argues that a lack of awareness amongst educators who facilitate the participation of students with disabilities in degree programmes could actually impose an initial barrier to student willingness to apply for geosciences, yet this issue is under-researched. This focus has therefore

shifted to educators who might engage with students with disabilities, to assess if there are pathways to improvement that will encourage these students to explore the geoscience path.

Geoscience Accessibility Researcher

A prominent accessibility researcher, who has won multiple awards for innovative teaching in the field for students with mobility and visual disabilities, and is a member of the International Association for Geoscience Diversity (IAGD), provided broad insight into the perceived barriers of accessibility across the geoscience discipline. The IAGD is an international organization that focuses on promoting inclusive instructional practices and research opportunities while raising awareness for improving access and engagement in the geoscience disciplines for students and geoscience practitioners with disabilities.

University Disability Services

In addition, a Dsability Services officer at UWE Bristol, who has have received a number of awards for their inclusivity work across the university and is familiar with the geoscience curricula in the Faculty of Environment and Technology, was asked to provide commentary on the statements gathered in the educator interviews. As such, this individual was well-informed to comment on the issues raised in the interview. Their responses have been integrated in the survey and interview evaluations.

Data Collection Instruments

Survey

To address the identified research questions, a survey was distributed through personal request emails, electronic mailing lists, and social media (Twitter). The surveys consisted of 11 short answer questions (Table 1), covering the educator knowledge of resources available for students with disabilities, their knowledge of classroom and field trip modifications and their awareness of

potential issues with the image of geoscience portrayed at open days and on websites. A total of 51 completed surveys were returned.

Table 1: Survey questions

Interviews

As this research focuses on perception of geoscience educators, the most appropriate follow-up for this qualitative exploratory study (Bajramovic *et al.*, 2004) was a semi-structured interview. This method has previously been applied to investigate perceptions of target groups (Bourne *et al.*, 2002) and allows sufficient space for the interview subject to elaborate on their answers, while still guided through the same themes as all other interview subjects.

Participants who completed the initial survey, sent through personalized electronic mail invitations, were asked to participate in an interview. The interview participants (n=7) were drawn from colleagues at a variety of institutions, covering the prestigious Russell Group (e.g. Cardiff University) as well as top 50 (e.g. Hull University and UWE Bristol) and smaller universities (e.g. University of Gloucestershire). They ranged from early career lecturers to senior lecturers, course leaders and laboratory technicians thereby creating a representative sample of educators in teaching positions.

Two additional interviews were conducted with the geoscience accessibility researcher and Disability Services representative. These interviews discussed consistent issues raised in educator interviews in order to map the perception of viability of geoscience as a degree choice for students with disabilities, and the specific support universities offer to those students who choose this degree. Additionally, these interviews discussed key issues of access and inclusion

in geoscience activities, such as the image of geoscience at Open Days - a day where prospective students are invited onto campus - and awareness of perceived barriers to participation for students with physical disabilities in all academic activities. Results of all interviews (n=9) are presented in the findings and discussion section below.

Data Analysis

After the interviews were conducted the results were collated to compare responses to the topics put forward for discussion. To analyze the text and group responses, descriptive thematic coding was used, as is advised for small sample numbers (Boyatzis, 1998). Themes frequently mentioned by participants were [1] perception (of access), [2] fieldwork, [3] degree promotion, and [4] personal engagement. Their responses were therefore collated according to these four themes to compare answers, and the attitudes and knowledge they represent, across the interviewee responses.

Results and Discussion

The interviews brought forward strong themes of perceived barriers, educator (in)action and varying levels of university support. These themes confirmed the statements made in the interview with the geoscience accessibility researcher who was specifically asked about image issues.

Perception of access and inclusion in the geosciences

On the topic of image issues the geoscience accessibility researcher was very clear: *"Absolutely yes.* ***Geosciences tend to portray themselves as a science for "able" people****, climbing mountains and going to remote locations. Quite often the diversity of jobs included in geosciences is not exploited in marketing the discipline."* Statements supporting this notion were directly identified in 27 (53%) of the surveys, with most of the remaining surveys indirectly identifying the issue. Keywords used included 'athleticism', 'rugged and outdoorsy', and 'ability to hike/get over

terrain'. One survey respondent noted that '***The stereotype [is] that geologists must do field work and that field work must involve long hikes, climbing, hauling samples – and that scientists who work mostly in labs or on computers are not "real" geologists'***. This image issue undermines the efforts of the international IAGD community who have developed specific accessible field studies. At the time of this study new field trips were announced that are specifically designed to be accessible. Often no major changes are required, simply a re-think of the sites to be visited and amending the logistics so transport can accommodate wheelchairs etc. Another option is to 'bring the outdoors indoors'. As the geoscience accessibility researcher confirms *"Fieldwork can really be designed in an accessible way, and also "**indoors" activities are underestimated in portraying geosciences** as a subject... The best example in other sciences I can think of is astronomy... I don't think any astronomer studying the sun has ever been there"*. Why are students expected to climb the mountain to understand stratigraphy? Is there a more appropriate field site that is accessible to all students? If that is not possible at all, and no alternative field site can be found, could a collection of hand samples in the laboratory combined with 3D models and data not achieve the same level of understanding? For example, recent advances in virtual reality (VR) and augmented reality (AR) have created a great opportunity to expose the entire student body to a much larger range of environments, for example as a means of preparing students for fieldwork (McMorrow, 2005; Liarokapis and Anderson, 2010) yet these are still limited in their integration in the curriculum. So even if finding an accessible field site to teach the students the skills and processes associated with the inaccessible site is not possible, there are alternatives that can still address these learning outcomes without excluding part of the student body. This also indicates a good avenue away from the perception that students with disabilities require major curriculum changes away from the 'climbing mountains' image; "*(…) the more I work with people with severe disabilities I realise **there is room for everyone in this science**. It is only a matter of finding the 'right place'."*

In response to these statements, educators were asked about their awareness and perceptions of issues of accessibility surrounding the participation of students with physical disabilities in geoscience undergraduate degree. The themes were structured around (a) perception of the issues, (b) institutional engagement with the issue, (c) individual engagement with the issue, and (d) structural changes that could be made to the curriculum to reduce the impact of the issue. The word 'fieldwork' was explicitly avoided in the framing of the questions, to test how much emphasis educators placed on fieldwork within the degree, and if they were aware of not only the obstacles placed in the path of students with disabilities s but also wider support and outreach to circumvent the obstacles.

Placing fieldwork

In the first section of the semi-structured questionnaire, the subjects were asked "Do you think that currently attracting students with physical disabilities to geoscience degrees is problematic?" One of the senior lecturers captured the problem particularly well, pointing out that educators cannot accurately assess the number of students who were initially interested in pursuing a geoscience degree but were put off by the outdoor image: *"This is tricky to answer because **I don't know how many physically disabled students consider a geosciences degree**, but then decide on an alternate course. I do know that, at UWE, we have recruited – and seen successful graduations – from students with a range of physical disabilities" (Senior lecturer).* However, the majority of survey respondents (n=46; 91%) agreed that attracting students with physical disabilities to geoscience degrees is problematic.

However, one of the course leaders interviewed did admit that perhaps there is a greater need of educator participation to prevent any applicants with physical disabilities from changing degree choice simply on the basis of perceived obstacles. Their statement incorporated the responsibility of the front line staff, predominantly the educators, to advertise the alternatives to the 'able bodied

geoscientist, climbing mountains' image that has been inadvertently cultivated through the use of words such as 'adventure' and 'explore' in conjunction with fieldwork. *"Yes, but based perhaps on their* ***perception of what is possible*** *rather than any barriers that geoscience degree providers put in the way….[it is] our responsibility to help change these perceptions" (Course leader).*

This resonates strongly in the way degrees are promoted. A search around promotion sites for BSc Geography and Geology degrees found that fieldwork is strongly pushed to the foreground, in line with the revised Quality Assurance Agency (QAA) benchmark statement for Earth sciences, environmental sciences and environmental studies (ES3; QAA, 2007) that "it is impossible for students to develop a satisfactory understanding of ES3 without a significant exposure to field-based learning and teaching, and the related assessment" (p.13). When the commonly accepted reasons for doing fieldwork are assessed for the potential participation of students with disabilities (shown in table 2), there is no valid reason to focus fieldwork in inaccessible places in order to achieve the objectives. Many of these objectives could be met in accessible field locations or the laboratory.

Table 2: Commonly cited justifications for the importance of fieldwork. Adapted from: Gold et al. (1991); pp.25-26 and Livingstone et al. (1998), p.3 In: Healy et al. (2001).

Fieldwork promotion language

The majority of survey responses (n=29) cited fieldwork as the most difficult obstacle to overcome. Concerns raised included access to field sites (n=18), the emphasis placed on fieldwork (n=14) as well as resources needed to increase accessibility (n=7).Though the geoscience accessibility researcher pointed out that all it often takes is small tweaks to field location choices, logistics and the balance between field and laboratory analysis to increase accessibility of field courses, it appears that undergraduate course promotion stubbornly adheres to the idea that exotic locations

and adventure are paramount in attracting applications, as illustrated in the introduction. In the context of an ever fiercer competition for student tuition fees it might be somewhat understandable that universities adhere to what is widely perceived to be attractive, as identified by two survey respondents. However, this does mean that students with physical disabilities are marginalized as a result.

A majority of universities do not explicitly advertise to attract students with disabilities. *"I don't think we go out of our way to attract physically disabled students and I don't think we would want to go fishing for them because* ***this sets them up as "different" from the start*** *– which is not how we want them [any student] to feel. Instead,* ***we deal with a student's particular needs as they arise, either through conversations at open day, or via meetings facilitated by Disability Services****. Our "Welcome to the Dep[artment]" lit display in a prominent position on the 4th floor, was deliberately designed to include photos of students with all physical (dis)abilities" Senior lecturer.* As one survey respondent pointed out: "*Identifying students with physical disabilities who may be interested in studying geosciences is difficult. If they have not already shown interest, I struggle with how to approach someone to include them without seeming awkward.* ***How do you make it clear that you're interested in including them for who they are and the gifts they bring rather than looking or sounding like you're approaching them BECAUSE of their disability?***'

Fieldwork as barrier

All interviewees and the vast majority of survey respondents (n=46; 91%) indicated fieldwork as one of the biggest barriers preventing students with disabilities participating in undergraduate geoscience degrees. However, it was also identified as a potential image problem: *"[There is a] strong emphasis on practical work and fieldwork.* ***Practical and field work is necessary for these degree programs****, and as a result, we emphasize this in descriptions of the subject area,*

through professional bodies and through degree programme marketing material. I can see that this would be off putting to a disabled student." (Early career lecturer). An early career lecturer at a different institution confirmed this: *"The practical and fieldwork element of the course are one of the main aspects that people consider, and so I imagine that this can be a perceived as a* ***difficult obstacle for people looking at the course and fully participating in it."*** This falls in line with Atchison's (2009) statement that "[w]ith the emphasis placed on field research at the undergraduate level, persons with mobility impairments face almost no chance of obtaining a higher education in the geosciences" (p 384).

However, not all interview subjects had a negative view of the situation: "*From my experience,* ***fieldwork has not been a significant obstacle****. If the terrain prevents a student from attending a field site, we have set up computer-based virtual field trips which have met the same learning outcomes as the field visit itself. In other cases, booking appropriate transport (e.g. coach with wheelchair access) has enabled the student to access the field" (Senior Lecturer)*. This is more in line with the statements of the accessibility researcher who pointed out that most field trips only need minor tweaks to increase accessibility.

So why is it not made clear to prospective students that physical ability is by no means a prerequisite for studying the geosciences? When asked, a senior lecturer expressed the discomfort that might be felt when addressing the surmountable nature of participation in advertisement and the difficulties in finding the right language: *"(…) conveying a clear message that physical disability is not an insurmountable obstacle to completing a geosciences degree [is difficult]. [When a student is enrolled], coordinating between teaching teams, Disability Services, family, to ensure the student is as supported as possible…without ever feeling as though they are being a "problem" (Senior lecturer).* The question is, how you can convey that a student with a disability will not be 'a problem' without either bypassing the (small) adjustments available to tailor

the course to their needs in promotional material, or using language that potentially patronizes students with disabilities and puts off all applicants? Shying away from all reference to accessibility in course promotion materials appears to lead to an oversight of not only what is possible within the degree course but what is available in terms of support on a university level as well: *"Most departments I know do/would offer accommodations to a physically disabled student – many field locations can be adapted to be accessible, virtual field courses can be used and most of our practical space offer accessible desk etc.* ***But unless a student inquires, they wouldn't realise this from the imagery used within our discipline*** *(which has a diversity issue in general)" (Early career lecturer).*

However, though the overriding issues mentioned by the educators included fieldwork, the issue of laboratory access was largely ignored. This might be because of the perception that laboratories are indoors and therefore automatically accessible, as the focus so far as largely lain with fieldwork. The laboratory technician interviewed pointed out that "*microscopes are not always accessible*", despite the requirement to use them within the curriculum, which was also confirmed by the 9% of survey respondents (n=5) who listed lack of accommodation for visual impairment as the primary obstacle for students with physical disabilities. To look down a microscope generally requires the student to stand up and peer down the eyepieces, which is not always possible (Bargerhuff and Wheatly, 2004). Considering the repeated suggestion of laboratory work as an alternative to less accessible field site, few laboratories appear to be equipped with accessible equipment. This severely hinders the opportunity for a student with a disability to participate not only in geoscience degrees but STEM degrees as whole (Duerstock, 2006). In fact, one of the survey respondents decided against enrolling in a petrology module because of microscopy access issues. The following year, screens were installed that would have addressed this issue, but this important course modification was not promoted and the student was not informed.

The geoscience disciplines do not solely consist of field and laboratory studies, as presented in the introduction. The spectrum of geoscience, and the employability skills associated with it, ranges from desk studies to experimental and laboratory studies as well as fieldwork. A preference for fieldwork is therefore not a prerequisite for success in geosciences, quite the contrary. This needs to be incorporated in our thinking as educators, not only in relation to students with physical disabilities but to the student body as a whole. As the geoscience accessibility researcher pointed out: *"I think the main obstacles come from the scholars.* ***Not all geoscientists look through the microscope or do fieldwork,*** *and I think geosciences in the widest sense may accommodate more people than many geoscientists think".* There are numerous pathways to learning in geoscience, including increased use of GIS / spatial analysis (i.e. Peirce, 2002; Seremet and Chalkley, 2015; Bearman *et al.,* 2016), simulation studies such as climate modelling (Tasquier *et al.*, 2016) and hydrological modelling through precipitation analysis and landscape sensitivity (Bormann and Caspari, 2015). At a more basic level, increased visualisation and interactivity of materials can replace the traditional approach of an oral explanation followed by a field visit (Libarkin and Brick, 2002) and shift the emphasis onto greater use of videos, images and interactive models. Integrating these universally-designed instructional strategies creates a varied curriculum that benefits the learning experience of all students (Carabajal, et al., 2017, Dunn et al., 2012; Rose and Meyer, 2002). Among the survey respondents, there appeared to be a willingness to explore these methods, but none of the respondents felt sufficiently supported with resources such as equipment and staff time allocation to fully implement universally-designed instructional enhancements. Further issues raised were the unwillingness of colleagues to step away from the comfort of teaching traditional field methods by utilizing technology enhancements such as data collection and note-taking, although most respondents felt a lack of *'freedom as educators to be able to try potentially risky things in our courses'* was also inhibitive of course development to enhance accessibility.

Perceived institutional support

On the topic of institutional support for students with disabilities, none of the interviewed educators felt that the university proactively provided support for students with disabilities, as covered in Section 2 of the survey. The survey responses were equally negative; when asked if their university makes enough of an effort to engage applicants with physical disabilities, 85% said 'no', 15% 'maybe'; none felt enough of an effort was made. When asked the same question about their department, responses were 88% 'no, 8% 'maybe' and 4% 'yes'. The selection of quotes below indicates the lack of either awareness on the side of the educators or the lack of support available within the university.

"No. As far as I am aware, **if an incoming student declares a physical disability, no action is taken** (e.g. signposting to them where they may be able to get support, asking if they require accommodations)" (Early career lecturer).

"No. Information is available on the website etc but **people have to look for it specifically**, and there is no signposting on the courses for students wanting this information" (Early career lecturer).

"No but I think you could argue the same for very many under-represented groups" (Course leader).

"**I don't think the university takes a proactive approach as such**, but in other areas it does engage with physically disabled faculty in a proactive way. I'd like to see / be aware of active engagement with students" (Senior lecturer).

“Within my organization no, not at the moment. This is an interesting question and I had to really think about the answer, we have lots of student Helpzone facilities available for people once they enter the university but **very little is set up to encourage people to apply**” (Early career lecturer).

What comes forward in this range of quotes is that among the interviewed educators there is a lack of understanding of the role the Disability Services Office plays in facilitating undergraduate students in geoscience degrees. Rather than working alongside the Disability Services Office to pre-empt barriers and integrate alternative learning methods, student needs are dealt with ad hoc by the educators. Ford et al. (2001) suggest bench marks that address the core of this issue, and that could be incorporated in a faculty development program, summarized below:

- Be committed to teaching the full range of learners with disabilities
- Have an understanding of disability that demystifies it and goes beyond the label to appreciate more fully what the range of abilities of the student are.
- **Be reasonably prepared to anticipate high-priority needs and effectively teach and make routine accommodations for students with disabilities**
- Prepared to work within an inclusive classroom and a collaborative teaching structure

The third point in particular is important here; rather than dealing with issues *ad hoc*, educators should anticipate a range of students with disabilities and preemptively design courses so they can include **all** students. This should then be included in the marketing strategy to ensure perceived barriers are taken down at the earliest opportunity for students considering applying for a geoscience degree: *“As a general statement, there is sufficient awareness on the need of engaging people with physical disabilities in the university, but there is not specific “marketing” strategy. If a prospective student with disability applies, his/her needs will be addressed, but there is* ***no specific effort on targeting students with disabilities to enroll****” (Early career lecturer).*

The surveys often cite a lack of training in accommodating students with physical disabilities in a sensitive and academically rigorous way. As such, should these educators be expected to take on this role if they do not feel supported by their university and department?

Personal engagement and outreach

The final section of the semi-structured interviews focused on educator awareness of outreach opportunities and the role they can play in encouraging students to apply for geoscience degrees. Of the survey respondents, 31% (n=16) had taken part in outreach events compared to those who had not (n=35; 69%). Responses here varied from a very short '*No*' when asked about previous participation, and '*None spring to mind*' when asked to identify opportunities for outreach when no personal action taken, indicating the difficulties educators experience in accessing and designing outreach activities. None of the interviewees, with the exception of the geoscience accessibility researcher, had taken part in outreach opportunities that specifically accommodated students with disabilities, though all participants agreed that there would be benefit in exploring the opportunities further. The survey respondents reported a wider experience with outreach events (n=16; 31%). One survey respondent stated that: 'Before the activity was over we would have a discussion about perceptions, or at least a survey, and participants [reported] that they never thought of disability and access in the context of geology or an educational setting, and many felt ridiculous it was something they never considered before'. In particular, IAGD and InSight geoscience workshops were pointed out as a successful demonstration that people with disabilities can succeed in geoscience. As Brewer (2010) points out, geoscience outreach can be used as a foundation for dispelling the myths of inaccessibility that surround these degrees. It would therefore be worthwhile to increase awareness of opportunities and train faculty to create opportunities within existing outreach collaborations that encourage students with disabilities to apply for geoscience degrees.

Findings, Recommendations, and Conversation Starters

Over the course of this exploratory investigation, a number of issues were identified which, when integrated into faculty training and curricular design, have the potential to mitigate perceived barriers of access and participation in geoscience courses.

Changing the PR language

The PR language used to promote degrees is one of the simplest problems to address; the geoscience community should consider changing the language from 'in the field' to 'field experience'. This by no means has to focus on accessibility issues and tailored towards students with disabilities, which could be construed as rather patronizing, but instead has to show that all students can participate in a range of learning experiences. Most urgently, the promotional material for undergraduate degrees needs to be adjusted to shift away from the promotion of rugged fieldwork and take a more inclusive approach. In addition, it needs to be made clear on the website that support for all students is provided at the course, departmental, and university levels.

The portrayal of the geosciences in recruitment materials is biased towards physical ability. This is particularly apparent in the language and imagery used in the promotion of geoscience undergraduate degrees. The repeated use of 'explore', 'adventure', 'trekking', and 'camping' creates an image of geoscience that excludes students who are not motivated by these activities. None of the websites provided indicated the potential for alternative sites or routes, instead referred to University Disability Services Office resources without a clear connection to course accessibility. This illustrates the lack of educator understanding regarding the role Disability Services Offices could play in mitigating barriers to accessible geoscience instruction before students contemplate degree choice. Mitigation might include close collaboration in the development of promotional materials, curriculum development support through the identification

of potentially difficult activities, and the development of accessible alternatives for field-based collaborations; all these activities together providing options for the whole student cohort. Instead, these services are used as a net to catch those students with disabilities who are intrepid enough to sign up for geoscience courses despite the PR emphasis on fieldwork. **Geoscience educators are recommended to work closely with PR services to ensure that the language used on the website reflects the whole curriculum, rather than pushing the fieldwork element, and where fieldwork is displayed create a clear link with accessibility and inclusivity.**

Changing the curriculum

A comprehensive change in the curriculum to be fully inclusive requires implementation of training for faculty. This includes identifying aspects of the curriculum that could pose barriers to student participation and how to make the small tweaks to enhance accessibility. It would be beneficial to have a stronger communication link between the department and the Disability Services Office, which is limited at best (Feig et al., 2019).

Geoscience educators recognize that fieldwork provides one of the largest barriers yet is touted as one of the main components of a geoscience degree. In a time when tuition fees have consistently risen and university rankings are increasingly seen as an important factor in student degree and institution choice there is a primary focus on increasing enrollment. In geoscience degree promotion, the fieldwork component is seen as an attractive part of the course, pictures of students climbing crags, coring in the middle of lakes and trekking across Iceland are bound to catch the eye of a student comparing their options across various institutions and degree. This has been carried further in the belief that fieldwork is a required aspect of a geoscience degree, despite the increasing availability of technologies such as remote sensing, GIS, virtual reality, and advanced laboratory investigations which are all integral aspects of geoscience research. Between the high tuition fees, cuts in DSA, and no guarantee that a student will be able to

participate in, let alone complete, a geoscience degree low participation levels should not be surprising.

Educators are quite optimistic about the integration of accessible fieldwork with geoscience degrees but few have actually undertaken steps to engage with this issue. Small instructional adjustments can be made that will make the difference for including students with physical disabilities. However, changing the curriculum to accommodate students with disabilities does not require a complete overhaul of the activities and learning structures of the degree; universally-designed instructional adjustments are clearly not obvious to the members of faculty. **Educators are recommended to evaluate not only the success of module components (such as fieldwork, laboratory work etc) but also the accessibility of each component. Based on these evaluation outcomes, making small scale changes throughout the curriculum can enhance the accessibility of a degree scheme without a full rewrite.**

Institutional support and resources

Outreach activities, which could be used effectively to lower the perceived barrier before the undergraduate application process starts, have not been utilized. None of the interviewees, with the exception of the accessibility researcher, had taken part in outreach activities that specifically aim to change the image of geoscience as a 'rugged and outdoorsy' degree choice. However, as most educators had taken part in general outreach activities that covered all age groups, there is no reason why the existing structures could not be expanded to showcase the diversity of geoscience and the accessibility of the vast majority of work carried out. This provides an excellent opportunity for a collaboration between geoscience educators and the Dsability Services Office.

The level of institutional support offered appeared to be quite unclear to the majority of educators. This actually is a symptom of a larger problem, where there is insufficient collaboration between

the Outreach Team, the Disability Services Office, and the geoscience educators. During an interview with the Disability Services Office representative they could not recall any of the team members having been contacted by a faculty member of Geography on any other basis than helping a student already enrolled on the course. While this research did not specifically set out to investigate the communication between the Disability Services Office and educators, it has become clear that the absence of active collaboration to increase undergraduate enrollment of students with disabilities might be an opportunity missed. If educators wait to contact the Disability Services Office until after students arrive in class, then developing strategies for accommodation are already too late.

Professional society and non-profit organization resources outside of the institution need to be better utilized. As an example, the IAGD has recognized and successfully explored several avenues of universally-designed fieldwork approaches that significantly enhance access and inclusion for all students. The changes required to existing curricula can be minimal, including the use of accessible sites such as road cuttings rather than relatively inaccessible sites at the end of difficult footpaths, integrating virtual reality further with fieldwork, and shifting the field analysis component from in-field mapping to more deliberate use of computer-based technologies such as large-scale data analysis and interpretation, remote sensing, and GIS. **Educators are recommended to be continually involved in curriculum evaluation and development by working closely with their institution's Disability Services Office (or equivalent) and seeking external instructional resources and strategies that promote access and inclusion.**

When barriers are identified, obvious patterns of repetition in outreach and promotional language are potential indicators that detract students with physical disabilities from considering to pursue a degree or career in the geosciences. This cycle of image reinforcement is illustrated in Figure 5.

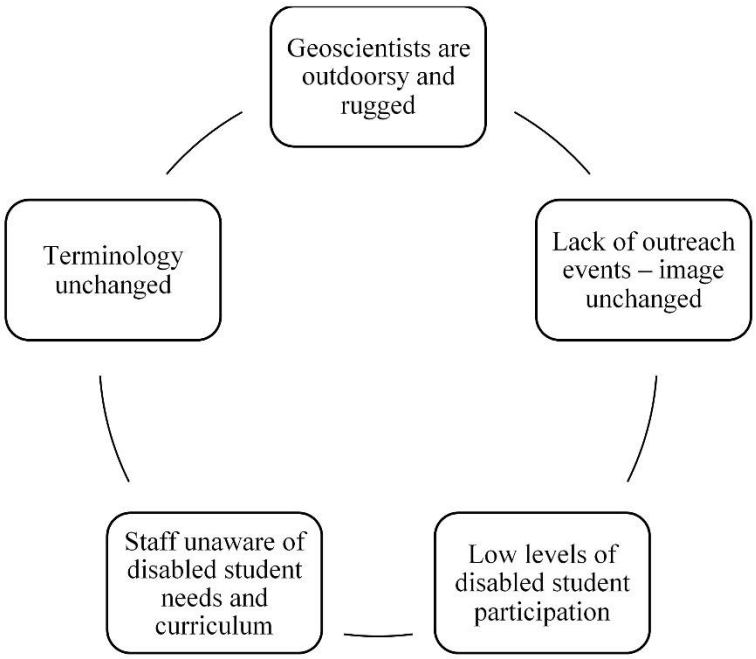

Figure 5: Cycle of image reinforcement

There are two pathways that need to be explored to address the perceptions of geoscience. First, outreach activities need to be utilized far more effectively to show that the geoscience discipline is more than just field-intensive studies, and should be promoted to depict the strengths and abilities of a diverse student community. Secondly, universal instructional strategies need to be integrated into existing curricula to increase accessibility across all geoscience coursework.

Limitations

As an exploratory pilot study, the authors were not able to generalize these initial findings across the entire spectrum of geoscience programs, but merely wish to provide justification for further investigation into the image portrayed by traditional geoscience methods. The overall research design and the small sample size do not provide a conclusive study into perceived barriers, but it does identify common themes that should be part of the conversations had in the geoscience

teaching community. Through this small-scale study, the authors recommend that more research focus on the investigation of this issue on a larger scale.

Conclusion

Over the course of this research it has become clear that there is a discrepancy between the image of geoscience and the instructional modifications that educators can use to reduce barriers and enhance accessibility. In particular, closer collaboration and communication between all stakeholders (educators, Disability Services Office, and (prospective) students) could lead to small but effective changes. It has also become clear that increasing accessibility is not a mountain to climb but rather a path of small adjustments and increased awareness. The findings have enabled personal reflection on the role, and responsibility, of educators in breaking down barriers, and identification of personal opportunities within the department to enhance accessibility, as illustrated in the initiatives section.

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