How does it feel? The affective domain and undergraduate student perception of fieldwork set in a broad pedagogical perspective

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Abstract: This study presents the results of an investigation of the undergraduate student perception of fieldwork, specifically in the context of the affective domain, and considers the effectiveness of field-based training as a pedagogical tool. Fieldwork provides the learner with a deep and immersive learning environment, where they are required to apply knowledge and theory acquired in class to the natural world, and to analyse its validity. Strong spatial and temporal reasoning skills are routinely employed, and construction of maps is central to the learning experience, as it requires students to carefully observe their surroundings and make informed and reasoned decisions as to what is truly important to document. As part of this study, students from a single higher education institution in Ireland were provided with anonymous questionnaires and polled for their opinions both prior to and following a phase of residential

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fieldwork. The results clearly show an appreciation of not just the cognitive benefits, but also the transferable, technical and social skills developed and improved through their varied first-hand real world fieldwork experiences. These findings are in keeping with those of previous studies. Overall, the student study group demonstrated enhanced affective domain responses to residential fieldwork: a recurring theme in the survey responses was recognition of the importance and value of sound observation and scientific rigor. These skills could subsequently be applied to many other areas of student learning, thus helping them to consolidate and integrate their knowledge base. The capacity of field training to transform the way students think (academically, but also socially) was quite evident, and they became knowledge generators rather than just knowledge recipients.

Keywords: Affective domain; fieldwork; geoscience; geology; pedagogy; situated learning.

I. **Introduction**

There is a long held appreciation in geoscience education of the value of field-based teaching, through the experiences of being on site and shared learning,[1] as part of a community of practice.[2] Fieldwork is seen as important in developing and enhancing cognitive and practical skills, and in acquisition of knowledge through direct engagement with real world geological phenomena in their natural contexts.[3] Feedback from both students and employers consistently refers to the importance of this activity in meeting the requirements of vocational and professional training. From a pedagogical perspective, fieldwork provides a unique opportunity for student engagement, occurring at a particularly immersive intersection between the learner and the institution.[4] This type of learning empowers students by facilitating this

[1] David W. Mogk and Charles Goodwin, "Learning in the field: synthesis of research on thinking and learning in the geosciences," in *Earth and minds: A synthesis of research on thinking and learning in the geosciences: Geological Society of America Special Papers 486*, eds. Cathryn A. Manduca and Kim A. Kastens (Boulder, CO: Geological Society of America, 2012), 134.

[2] Etienne Wenger, *Communities of Practice. Learning, meaning and identity* (Cambridge, UK: Cambridge University Press), 73.

[3] Heather L. Petcovic, Alison Stokes, and Joshua L. Caulkins, "Geoscientists' perceptions of the value of undergraduate field education," *GSA Today* 24, no. 7 (July 2014): 7, https://doi.org/10.1130/GSATG196A.1.

[4] Ella R. Kahu and Karen Nelson, "Student engagement in the educational interface: understanding the mechanisms of student success," *Higher Education Research & Development* 37, no. 1 (Spring 2018), 59, https://doi.org/10.1080/07294360.2017.1344197.

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engagement, and the situated learning environment[5] allows them to feel part of the larger geoscience community.[6] Additionally, students appreciate the training and social benefits (in terms of class- and confidence-building) that fieldwork affords.[7,8] Various forms of student and employer feedback have been used to hone and refine fieldwork programmes in the earth sciences, reflecting changes in technology and changes in educational approach. However, while it has been suggested that there is a trend away from fieldwork (and field-based instruction) towards modeling and simulation, it can be argued that direct, first-hand field experience can make interpretation of such model outputs more robust and reliable.[9] While the importance of field-teaching is acknowledged by practitioners and researchers, less focus has been placed on what undergraduate students think about fieldwork.

II. **Project aims**

The aim of this project is to investigate *undergraduate student perception* of fieldwork, in the context of the affective domain, and to seat the practice in a pedagogical context. The students who participated in this study were second, third and fourth (final) year Earth and Ocean Science (EOS) undergraduates in NUI Galway. The specific research questions being considered are:

1. What is the impact of fieldwork on the student affective domain?
2. Do student attitudes to learning change following completion of fieldwork?
3. Does fieldwork have the same impact on all students?

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[5] John S. Brown, Allan Collins, and Paul Duguid, "Situated Cognition and the Culture of Learning," *Educational Researcher* 18, no. 1 (January 1989), 32, https://doi.org/10.3102/0013189X018001032.

[6] Niamh Moore-Cherry, Ruth Healey, Dawn T. Nicholson, and Will Andrews, "Inclusive partnership: enhancing student engagement in geography," *Journal of Geography in Higher Education* 40, no. 1 (Spring 2016), 86, https://doi.org/10.1080/03098265.2015.1066316.

[7] John Murray et al., "Fieldwork in the context of Earth & Ocean Science training," *Discover, Explore, Create: 12th Galway Symposium on Higher Education, (June 6, 2014)*, Centre for Excellence in Learning & Teaching, National University of Ireland, Galway.

[8] Steven J. Whitmeyer et al., "Why Ireland? Analyzing an international field experience on its tenth anniversary" (Paper No. 275-9, GSA Annual Meeting, Vancouver, British Columbia, 19-22 October, 2014).

[9] Tim P. Burt and Jeff J. McDonald, "Whither field hydrology? The need for discovery science and outrageous hydrological hypotheses," *Water Resources Research* 51 (August 2015): 5921, https://doi.org/10.1002/2014WR016839.

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Boyle et al.[10] provide a clear distinction between the cognitive and affective domains of learning: cognitive activities involve the processing of information and construction of meaning, whereas affective activities deal with emotions, feelings and values. They also note that positive outcomes in the affective domain are considered important for subsequent success in the cognitive domain. Over a number of years, EOS staff at NUI Galway have gathered anecdotal information from students and alumni, all of whom spoke very positively about the impact that fieldwork had made on their outlook:

> *The fieldtrips were excellent, many people believe that being taught something in a classroom environment is enough, however, nothing compares to going out into the field and practicing these methods.*
>
> *The fieldtrip elements of the course were an invaluable aspect, resulting in hugely accelerated learning, despite the obvious budget constraints within the department.*[11]

Boyle et al.[12] suggest that fieldwork is good if positive emotional responses are triggered in the student. This appears to reflect the anecdotal experience in EOS, but when a more structured and rigorous approach to data collection and analysis is taken, is this still the case?

III. **Theoretical and broad context of the importance of fieldwork**

> *Gold is where you find it, according to an old adage, but judging from the record of our existence, oil must be sought first of all in our minds.*[13]

The essence of the above statement is that both the human mind and practical experience are critically important tools for the earth scientist; therefore, a hallmark of the geosciences is the requirement for field-learning.[14]

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[10] Alan Boyle et al., "Fieldwork is Good: the Student Perception and the Affective Domain," *Journal of Geography in Higher Education* 31, no. 2 (2007): 301, https://doi.org/10.1080/03098260601063628.

[11] Two anonymous pieces of feedback collected from final year EOS undergraduate students and alumni by the Centre for Excellence in Learning and Teaching in NUI Galway in 2012.

[12] Boyle et al., "Fieldwork is Good," 315.

[13] Wallace Pratt, "Towards a philosophy of oil finding," *Bulletin of the American Association of Petroleum Geologists* 36, no. 12 (1952): 2231.

[14] Cathryn A. Manduca and Kim A. Kastens, "Geoscience and geoscientists: uniquely equipped to study Earth," in *Earth and minds: A synthesis of research on thinking and learning in the geosciences: Geological Society of America Special Papers 486,* eds. Cathryn A. Manduca and Kim A. Kastens (Boulder, CO: Geological Society of America, 2012), 3.

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Fieldwork has been highly valued in geoscience education and it remains a pedagogical cornerstone of the subject. At its most basic, it concerns observation and curiosity and it provides students with a skillset that empowers them to begin reading, interpreting and representing the landscape.

This perspective is widely acknowledged in the literature: the importance, benefit and value of geoscience fieldwork has been previously noted,[15] theoretical advances in geoscience are usually grounded in direct observation,[16] and fieldwork is highly valued within the earth sciences as a learning activity.[17] Mogk and Goodwin[18] open their wide-ranging review of the literature pertaining to field-based learning, by asking if there is evidence that fieldwork is a critical component of geoscience education. They provide ample evidence that fieldwork is indeed critical, but more importantly they seat it in a rigorous pedagogical setting. Geoscience education and field-based teaching can be mapped in terms of the cognitive, affective, metacognitive and social ways of knowing.[19] This has been termed *practitioners' wisdom,*[20] in that there is due acknowledgement that is above anecdotal level, but not rigorously established through focused research. Fieldwork provides students with unique opportunities to study the real and complex world. Their perception of fieldwork is typically positive: it can reinforce classroom-based learning and improve geoscience knowledge, skills and understanding.[21] Fieldwork not only provides students with first-hand real world experiences that facilitate development of transferable and technical skills, but social benefits also accrue: students get to know their classmates better (building or reinforcing a sense of belonging to a coherent group), and they develop a sense of being part of a broader geoscience community of learning. These themes have previously been developed and quite comprehensively examined.[22,23]

Fieldwork has the potential to engage student cognitive, affective, and psychomotor skills (Figure 1; in particular it could perhaps occupy the

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[15] Burt and McDonnell, "Whither field hydrology?," 5921.

[16] Kim Kastens et al., "How geoscientists think and learn," *EOS Transactions American Geophysical Union* 90, no. 31 (August 2009): 266, https://doi.org/10.1029/2009EO310001.

[17] Petcovic, Stokes, and Caulkins, "Geoscientists' perceptions," 4.

[18] Mogk and Goodwin, "Learning in the field," 137.

[19] Manduca and Kastens "Geoscience and geoscientists," 10.

[20] Mogk and Goodwin, "Learning in the field," 137.

[21] John Maskall and Alison Stokes, *Designing Effective Fieldwork for the Environmental and Natural Sciences* (York: Higher Education Academy, 2008), http//www.gees.ac.uk/pubs/guides/fw2/GEESfwGuide.pdf.

[22] Mogk and Goodwin, "Learning in the field," 154-157.

[23] Manduca and Kastens, "Geoscience and geoscientists," 7-8.

intersection point of all three domains on the Venn diagram), all of which contribute to learning.[24,25] Taking a "metacognitive" approach to instruction is useful: the students learn to think as geoscientists, to help solve problems. This allows them to take ownership of their own learning by defining learning goals and monitoring their progress as they work.[26] Field experience is thus transformed into knowledge.[27]

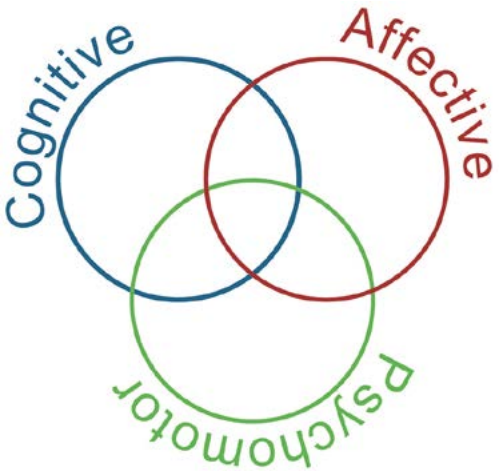

Figure 1

Venn diagram of the three domains of educational activities or learning

Note how each of the fields are not mutually exclusive and the potential that exists for domain overlap, to varying degrees. Certain learning activities, such as attending lectures, might preferentially lead to cognitive development, whereas engagement in classes with a strong practical component (such as labs) might improve both cognitive and psychomotor skills.

Being in the field also motivates students to learn. This total sensory engagement makes for memorable learning experiences, which are subsequently

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[24] Benjamin S. Bloom, *Taxonomy of Educational Objectives: The Classification of Educational Goals* (New York: David McKay Company, 1965).

[25] David R. Krathwohl, Benjamin S. Bloom and Bertram B. Masia, *Taxonomy of Educational Objectives; the Classification of Educational Goals. Handbook II: Affective Domain* (New York: David McKay Company, 1973).

[26] Mogk and Goodwin "Learning in the field," 142.

[27] David A. Kolb, *Experiential Learning: Experience as the Source of Learning and Development*, 2nd ed. (Upper Saddle River, New Jersey: Prentice Hall, 2015).

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used to aid recall and application.[28] A strong social relationship develops between the students, and their teachers, that has a strong affective impact.[29] Affect and cognition are closely linked,[30,31] and positive affective aspects are important for motivating and preparing students to learn.[32,33]

The immersive setting of field-learning allows students experience their surroundings from an enclosed perspective (they are within the larger object of study). They must record their observations in the complex context of their surroundings, and they thus tend to develop knowledge about the natural world that is markedly different from that obtained from artificial "representations".[34] This situated learning allows students to develop a deeper understanding of fundamental principles – such as the scale of geological phenomena (including deep time) and the significance of their spatial relationships: concepts and ideas that can be difficult to communicate in a classroom, laboratory or virtual learning environments. The geological record is inherently incomplete, and data collected in the field can be complex and ambiguous, so geoscientists – and geoscience students – have to learn to reason by analogy and strong inference in order to make better sense of the natural world.

Embodiment is an important component of human cognition and is an essential tool that allows geoscientists to organize and enhance knowledge.[35] Field-based learning permits students to acquire embodied skills that develop within natural *and* social contexts. The former include ways of knowing about how to interact with the outside world, while the latter involves all of the interactions that can be used to organize, prioritize, and share knowledge: taken together, this can lead to an agreed and collaborative understanding.

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[28] Murray G. Millar and Karen U. Millar, "The effects of direct and indirect experience on affective and cognitive responses and the attitude-behaviour relation," *Journal of Experimental Social Psychology* 32, no. 6 (November 1996): 577, https://doi.org/10.1006/jesp.1996.0025.

[29] Boyle et al., "Fieldwork is Good," 315.

[30] Justin Storbeck and Gerald L. Clore, "On the interdependence of cognition and emotion," *Cognition and Emotion* 21, no. 6 (Autumn 2007): 1213, https://doi.org/10.1080/02699930701438020.

[31] Luiz Pessoa, "On the relationship between cognition and emotion," *Nature Reviews Neuroscience* 9 (February 2008): 148, https://doi:10.1038/nrn2317.

[32] Boyle et al., "Fieldwork is Good," 314.

[33] Alison Stokes and Alan Boyle, "The undergraduate geoscience fieldwork experience: Influencing factors and implications for learning," in *Field Geology Education – Historical Perspectives and Modern Approaches: Geological Society of America Special Paper 461*, eds. Steven J. Whitmeyer, David W. Mogk, and Eric J. Pyle (Boulder, CO: Geological Society of America, 2009): 292.

[34] Charles Goodwin, "Professional vision," *American Anthropologist* 96 (1994): 628.

[35] Mogk and Goodwin "Learning in the field," 143.

Fieldwork immerses students in a social setting where they can observe how a community of practice develops and functions. Situated practice in fieldwork classes underpins and grounds the professional practices that define geoscience more broadly. This includes

> *the testing and vetting of methods, appropriate selection and use of tools, creation and use of inscriptions to confer meaning, norms and models for social interactions, personal and professional work ethics such as perseverance and integrity, and communication through gesture, representations, and words that animate the profession*.[36]

A geoscientist gains invaluable experience in the field, particularly when working with and learning from more experienced practitioners,[37,38,39] and the skills, attitudes and approaches all have direct connections to learning and working in a field-based setting. Student geoscientists gain experience in the field, and can systematically add to their information reservoir, for later access (in memory) as points of reference with which to compare and assess new information. Students become more capable of transferring lessons learned from one experience to new situations – even in the simple case of recognizing a particular rock type or geological horizon again at a different location. As geoscience students learn how to transform information about the Earth into knowledge, they are themselves transformed as individuals into the ranks of geoscientists. The students are not only knowledge recipients, but also knowledge generators.[40] Geological epistemology is built on its tradition as an interpretive and historical science,[41] and this tradition derives largely from field studies.

IV. **Methodology**

A paired questionnaire approach was used in this study: students were asked to complete a questionnaire before embarking on residential fieldwork,

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[36] Goodwin, "Professional vision," 614.

[37] Goodwin, "Professional vision," 615.

[38] Edwin Hutchins, *Cognition in the Wild* (Cambridge, MA: Massachusetts Institute of Technology Press, 1995).

[39] Tim Ingold, *The Perception of the Environment: Essays in Livelihood, Dwelling and Skill* (London: Routledge, 2000).

[40] Rob C. de Loë et al., *From Government to Governance: A State-of-the-Art Review of Environmental Governance. Final Report. Prepared for Alberta Environment, Environmental Stewardship, Environmental Relations* (Guelph, ON: Rob de Loë Consulting Services, 2009): 26.

[41] Robert Frodeman, "Geological reasoning: Geology as an interpretive and historical science," *Geological Society of America Bulletin* 107, no. 8 (August 1995): 960, https://doi.org/10.1130/0016-7606.

and to complete a second following completion of the course. A modified version of the Boyle et al.'s questionnaire[42] was used that was deemed more appropriate for the present study cohort, which was drawn exclusively from the undergraduate EOS programme at NUI Galway. Permission was sought from Alan Boyle to use a modified version of his questionnaire, and he kindly agreed and supplied digital templates.

A mixture of Likert-scale, ranking, free-form text entry, and respondent-specific (e.g. gender, age, previous experience) questions were organized under the following sections using Boyle et al.'s approach (for the pre-field-class questionnaire):

- Core Data (*respondent specific*)
- If you have been on fieldwork before what was your most memorable fieldwork experience? (*free text*)
- Which three of the 10 following descriptions best describe your feelings about the fieldwork you are about to undertake as part of your degree programme? (*ranking*)
- Anticipation of the fieldwork (*three-point Likert*)
- Knowledge to be gained (*five-point Likert*)
- Perception of fieldwork as being useful (*five-point Likert*)
- Collaboration, enjoyment and motivation (*three-point Likert*)
- Procedures and techniques in fieldwork (*five-point Likert*)
- What do you hope to get out of this fieldwork? (*free text*)

The post-fieldtrip questionnaire was similarly formulated, but with questions posed in a more reflective manner, rather than the anticipatory approach employed in the pre-fieldwork questionnaire. For free-text questions rather than the anticipatory questions, the post-fieldwork questionnaire asked:

- What were your worst and best experiences?
- What skills have you learnt or developed during the field trip? *and*
- How has your relationship with the other students and with staff changed as a result of the field course?

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[42] Boyle et al., "Fieldwork is Good," 302-303.

In the EOS degree programme residential (extended-time) fieldwork is not undertaken in first year, so only second, third and fourth year students were invited to participate in the study. The entire class cohort was briefed about the study and the need for student involvement. Volunteers were sought from each group and the process then further explained. The size of the student cohort from the three years of the EOS degree (2015-2016) was 94 in total (*Table 1*). Nineteen (19) second year, 18 third year and 14 fourth year students completed the pre-fieldwork questionnaire, with 14, 15 and 14 (respectively) completing the post-trip form. A total of 51 students across all years (54% of the total student cohort) completed one or other of the questionnaires, but only 43 (46% of the total student cohort) completed both.

Each student who took part in the study was asked to use one of three identifiers based on their year of study, followed by a number randomly selected between 1 and 35 (by the student). Each form was pre-coded with the identifier (*EOS3_28*, for example, referred to a 3rd year student) and students were asked to remember their number and use it again on the follow-up questionnaire. The discipline administrator and a postgraduate student took responsibility for distribution and collection of the questionnaires.

V. **Ethical issues and approval**

Prior to undertaking this research an ethics application was submitted to the Ethics Committee in NUI Galway, and approval was subsequently granted. Key issues of confidentiality and trust are raised in studies of this kind; it is important that participants feel that the information they share will be treated with respect and used solely for the reasons stated. In this case the volunteer participants were briefed about the context and overall aims of the study, and they were provided with a briefing document based on the ethics application. A consent form was included confirming that the data and results would be used only for this research and that no identifiers would be used that could in any way be associated with any participant.

It was stressed at *all times* that the student participation was entirely voluntary and outside any formal examination or assessment process. The success of the project was entirely reliant on student input and goodwill, and they were reassured that they could choose not to continue with the process at any point, and that any such decision would not be viewed negatively.

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Insider research may be defined as *"investigation conducted by people who are already members of the organization or community they are seeking to investigate as a result of education, employment, social networks or political engagements"*.[43] Researching professional education as an insider educator-researcher must be carefully considered given that the study audiences may include current students.[44] Insider researchers, along with their supervisors and staff on ethics committees, need to be conscious of potential risks and must plan against their possible impacts. The aim is to become *risk-aware* rather than *risk-averse*; insider research can provide extremely useful and powerful data, eliminating risks can be impractical and complicated.[45] In this particular instance, the investigators actively teach the students and supervise some of their undergraduate work. This emphasized the need for complete student anonymity, and to ensure that the responses would be treated respectfully and only to inform this research. While there is a potential power differential it is also important to stress that the success of the research was entirely dependent on voluntary student participation. For the purposes of the present investigation the researchers were thus careful not to be involved in overseeing the completion of the surveys, and were careful not to have any interaction with the students before or after the surveys were completed.

VI. **Results**

The survey results are considered here in the context of the grouped questions: (1) anticipation and reflection, (2) knowledge and usefulness, (3) collaboration and enjoyment, and, (4) procedures in the field. The results are presented as statistical data (in tabular and chart form) and open text. The latter are indented and italicised, and the source questionnaire reference is provided (as above, *EOS3_28* for example, is a 3rd year EOS student).

A general overview of the respondents is presented in Table 1. The 51 students who completed at least one questionnaire were approximately evenly divided in terms of gender (25 female, 26 male). About 80% of the participants live away from home during term time.

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[43] David Coghlan and Teresa Brannick, *Doing Action Research in Your Own Organization, 4th Ed*. (London: SAGE Publications, 2014).

[44] Caroline Humphrey, "Dilemmas in doing insider research in professional education," *Qualitative Social Work* 12, no. 5 (September 2013): 573, https://doi.org/10.1177/1473325012446006.

[45] Humphrey, "Dilemmas in doing insider research," 582.

Table 1

Summary of student participant demographics

Year of study	Total Class Size	# of Participants	% Class participation	Age	Gender	Living at home
2nd	25	19	76%	15 <20 4 >21	11 F 8 M	6
3rd	34	18	53%	8 <20 10 >21	9 F 9 M	2
4th	35	14	40%	14 >21	5 F 9 M	2

VI.1. *Anticipation and reflection*

The questionnaires contained two sections on *anticipation* and *reflection*. In the first of these, students were asked to rank their feelings before and after

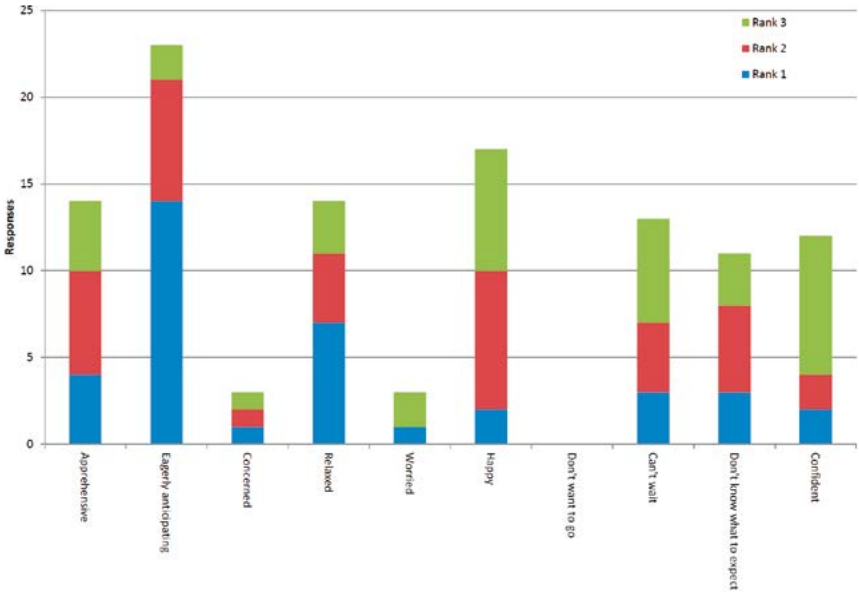

Figure 2

Pre-fieldwork rankings of second and third year student feelings towards the forthcoming residential trip

Respondents ranked top three feelings from choice of 10 listed; rank 1 is deemed most important and rank three the least important.

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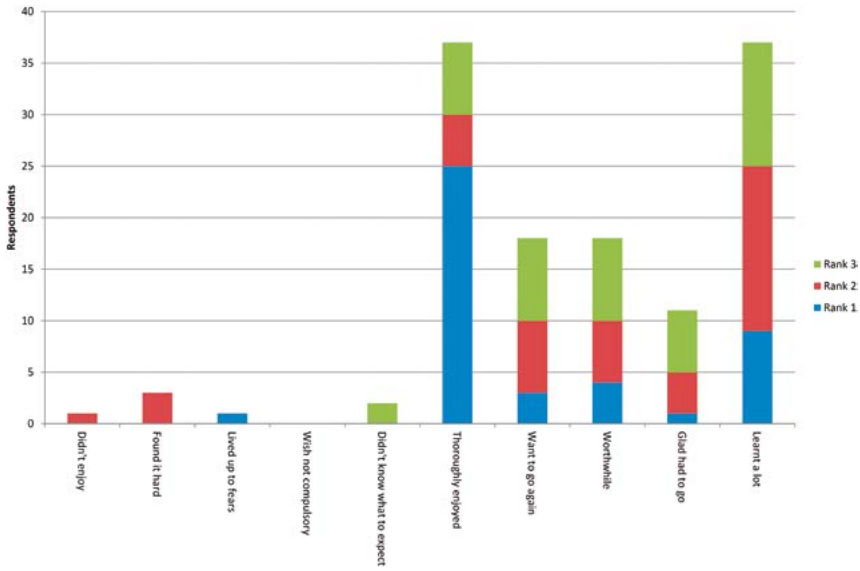

Figure 3

Post-fieldwork rankings of student feelings (from all years) towards the field-based learning activity

Respondents ranked top three feelings from choice of 10 listed.

completing the fieldwork by ranking their top three choices from 10 options. The outcomes are presented in Figures 2 and 3, which show (respectively) the results from the second and third year classes before the fieldwork was completed and the results and reflections from all three years polled following completion of fieldwork.

About 21 percent of students ranked *eagerly anticipating* in their top three feelings of anticipation and 15 percent ranked *happy* in their top three. *Relaxed* and *apprehensive* were ranked by 13 percent of respondents and only three (3) percent of students ranked *concerned* or *worried*. No individual selected *don't want to go* in their top three. Positive pre-fieldwork feelings were expressed 79 times (72 percent) with negative ones expressed 20 times (18 percent).

In contrast, the post-fieldwork results are uniformly positive: 121 of 128 ranked responses were positive (95%), while only five (5) were negative (4%). The feelings of *apprehension*, *concern* and *worry* were not reflected in post-fieldwork responses.

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In the second section – relating to anticipation – students used a three-point scale (*positive, neutral, negative*) to indicate their feelings about a series of fieldwork activities. Their pre- and post-fieldwork statements could then be more rigorously compared, thus giving a means of assessing the impact of the fieldwork experience on student feelings of anxiety.

The pre- and post-fieldwork responses are shown in Figures 4 and 5 (positive and negative responses respectively) that highlights the contention that there is a reduction in negative feelings, coupled with an increase in positive feelings, associated with completion of fieldwork. The results show that whereas the incidence of positive responses was subsequently slightly lower for two activities (visiting a different place, meeting people from a local community), increases were observed in all other aspects (this outcome matches closely the findings of Boyle et al.[46]). The biggest percentage increase was noted in the category *sharing rooms*, which likely reflects a breaking down of social barriers and a greater sense of class cohesion developed a result of living and working closely together.

The impact of the fieldwork experience on reducing the incidence of negative responses is unequivocally clear, with reductions observed in *all* of the eight aspects. Negative responses to feelings were only recorded under three headings: *working outdoors* (three percent pre-fieldwork, zero percent post-fieldwork), *sharing a room* (eight percent pre-fieldwork, two percent post-fieldwork), and *academic demands* (two percent post-fieldwork). Open question student responses also reflect this positive shift in opinion:

> *Relationship with other students has changed very positively, mainly through sharing accommodation* (EOS4_22).
>
> *If anything, I felt healthier after the fieldwork* (EOS4_20).
>
> *Books and lectures are not enough* (EOS4_14).
>
> *I struggled with geology before, but then Wexford really made it click for me* (EOS4_23).

VI.2. *Knowledge and usefulness*

How students *perceive* the academic value of fieldwork is useful in assessing the impact of fieldwork in the affective domain. These questions assess students' confidence in the validity of the learning method, and the

[46] Boyle et al., "Fieldwork is Good," 306.

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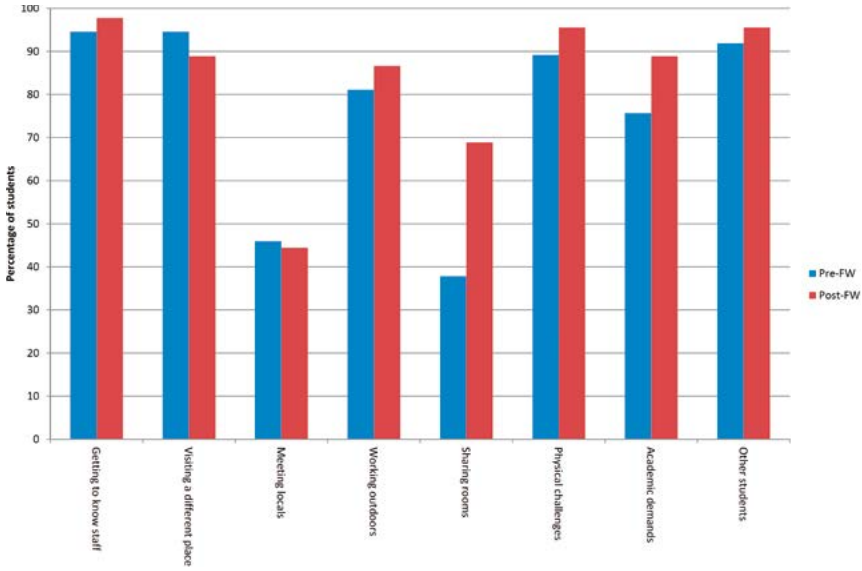

Figure 4

The effect of the field experience on positive responses to student feelings

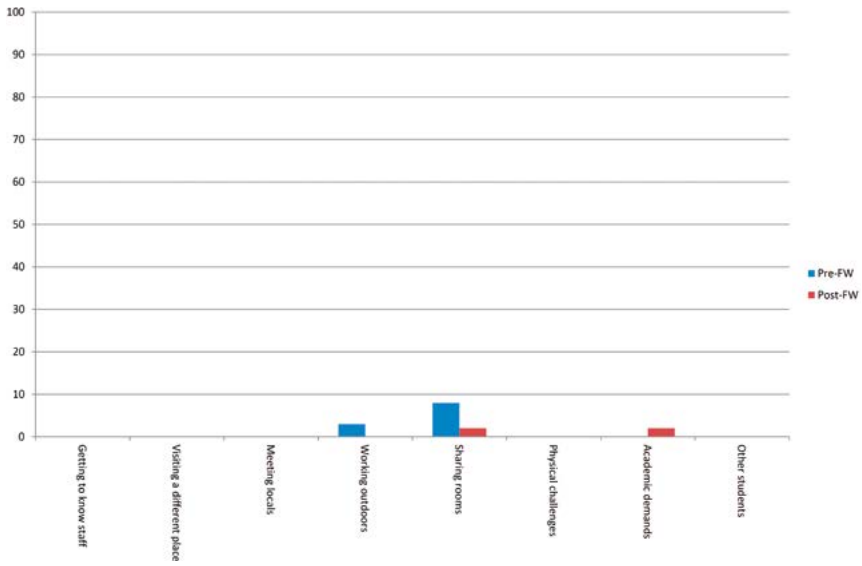

Figure 5

The effect of the field experience on negative responses to student feelings

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responses can be read as in indicator of motivation. All questions relating to these sections on the questionnaires used a Likert scale, and all that were posed in the *Knowledge* section showed a significant agreement with little difference between the pre- and post-fieldwork responses (*Table 2*). The respondents had a high level of agreement with the statements pre-field class, and this was not changed by the subsequent fieldwork experience. However, the question concerning the perceived importance of fieldwork showed a pronounced significant shift; in the post-fieldwork answers this was seen as much more important. This moved from having the lowest mean score pre-field class to the highest afterwards (*last row in Table 2*).

The summary analysis of questions on the *usefulness* of fieldwork is presented in Table 3. Student responses are extremely positive towards fieldwork for all question pairs. In the pre-fieldwork answers, students stressed the importance of learning in the field in comparison to learning in the library, and this was more significantly reinforced following the fieldwork. Again, this final question mirrors the findings of Boyle et al.[47]

These findings were also reflected in many of the free text responses:

> *Gained a huge amount of knowledge across all EOS subjects* (EOS3_08).
>
> *Practical skills reinforced my knowledge through lots of disciplines…diagrams and slides no make more sense as I saw real examples in the field* (EOS3_17).
>
> *It became very clear why certain observations are made and how important it is to get the info collected in location* (EOS3_14).

Table 2

Analysis of Knowledge questions

No.	Knowledge	Pre-FW Mean	Post-FW Mean
1	Fieldwork will increase my knowledge of subject	4.97	4.84
2	First-hand experience on theme/topics studied in class makes it easier to understand them	4.95	4.68
3	Fieldwork gives me a chance to develop problem-solving skills	4.65	4.43
4	University geoscience courses all do fieldwork so it must be important	4.41	4.84

5-point Likert scale used where 1 = *totally disagree* and 5 = *totally agree.*

[47] Boyle et al., "Fieldwork is Good," 311.

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Table 3

Analysis of Usefulness questions

No.	Knowledge	Pre-FW Mean	Post-FW Mean
1	It is important to know how to solve problems in the field	4.76	4.91
2	Without field experience my degree would be too academic	4.73	4.84
3	Fieldwork skills will be important to me in my career	4.84	4.64
4	Fieldwork will help my understanding of the subject	4.92	4.68
5	It would be more useful to spend time in the library	2.10	1.43

5-point Likert scale used where 1 = *totally disagree* and 5 = *totally agree.*

VI.3. *Collaboration and enjoyment*

While group work is commonly a more prominent feature of the fieldwork learning experience, in comparison to most campus-based courses, EOS students still complete a reasonable amount of group activities in their practical and laboratory classes. The EOS fieldwork programme is focused on development of group working skills and encourages students to take ownership of their learning. The findings of this study (Figures 6 & 7) clearly reveal stronger positive affective responses towards group work.

More of the responses in both pre- and post-fieldwork questionnaires emphasize the importance of student collaboration and enjoyment, but it is noticeable that in the latter more students answered definitively rather than offering a neutral response. There are significant indications that more students *actually* enjoyed the fieldwork, the challenges it offered, and the various aspects of group work than their pre-fieldwork anticipation indicated:

> *I feel that I have become closer friends with my classmates who I did not previously know too well* (EOS3_10).
>
> *I have become so much closer with my fellow students because of it. It improved by relationships with the staff and made me feel more comfortable to approach staff with questions regarding subjects I am struggling with* (EOS4_23).
>
> *I have made many friends and developed relationships through fieldwork. It has also made me more confident in an academic sense* (EOS4_23).

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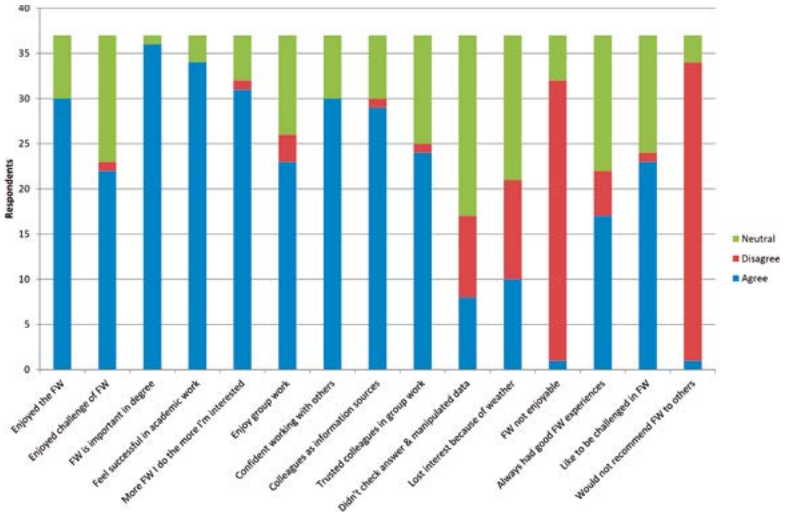

Figure 6

Pre-fieldwork rankings of student enjoyment and motivation

Respondents selected Agree, Disagree or Neutral responses.

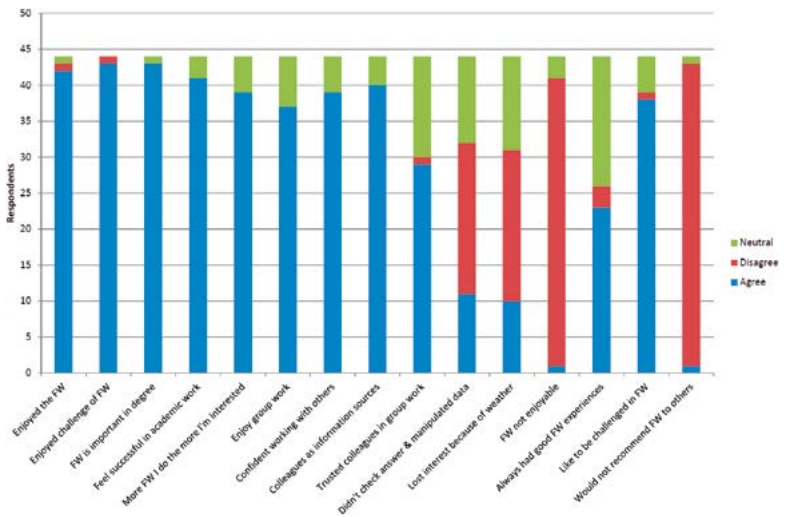

Figure 7

Post-fieldwork rankings of student enjoyment and motivation

Respondents selected Agree, Disagree or Neutral responses.

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> *My best and worst experiences were the same, my final year mapping project. Trying to live and work in the immensely challenging weather conditions was one of the most difficult experiences of my life, but one which I am incredibly proud of myself for overcoming and for helping my mapping partners overcome* (EOS4_26).
>
> *The most memorable part was the fun I had getting to know my classmates better and also getting to know the lecturers better* (EOS4_14).
>
> *I feel we all got to know each other a lot and everyone got on really well. I got to know those I didn't know before, especially the mature students who I wouldn't have interacted with before* (EOS2_03).
>
> *Learning to value the observations and interpretations made by my peers* (EOS4_20).
>
> *…also how to work well in a team, see other people's point of view* (EOS4_30).

VI.4. *Fieldwork procedures*

As noted previously, the focus of this investigation was to examine the impact of fieldwork on student feelings and emotions (affective domain), rather than its direct influence in the cognitive domain, with the suggestion being that positive developments of the former lead to positive impacts on the latter.[48,49,50] A small number of the questions did investigate students' self-evaluation of their working procedures (Tables 4 & 5). These results indicate their awareness of the importance of making good observations before embarking on the fieldwork, and that those impressions were strengthened afterwards:

> *Field mapping on the last two days as it was relaxed but also self-driven* (EOS3_17).
>
> *It became very clear why certain observations are made and how important it is to get the info correct on location* (EOS3_14).
>
> *It was like travelling back in time and getting a real experience of how important geology is in all of our lives* (EOS2_21).

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[48] Edwin Kern and Jane Carpenter, "Effect of field activities on student learning," *Journal of Geological Education* 34, no. 3 (1986): 180.

[49] David Stoddart, *On Geography,* (Oxford: Blackwell, 1986).

[50] Denis Cosgrove and Stephen Daniels, "Fieldwork as theatre – a week's performance in Venice and its region," *Journal of Geography in Higher Education* 13, no. 2 (1989): 170, https://doi.org/10.1080/03098268908709082.

Table 4

Student response to field procedures (pre-fieldwork)

		Agree	Neutral	Disagree
1	Careful to record observations	28	8	1
2	Use of technical equipment easy	31	4	2
3	Pre Fieldwork information useful	22	13	2

Table 5

Student response to field procedures (post-fieldwork)

		Agree	Neutral	Disagree
1	Careful to record observations	35	8	1
2	Use of technical equipment easy	28	15	1
3	Pre Fieldwork information useful	32	11	1

It is interesting to note that the strongest neutral responses were provided in relation to the information provided to students in advance of the field campaign. This might suggest that while the information provided is deemed sufficient, alternative methods of informing students could also be explored.

VII. **Discussion**

The three research questions posed at the beginning of this report (concerning the impact of fieldwork on the student affective domain, student attitudes to learning, and the capacity of field learning to elicit an equal response amongst a group of students) all essentially ask how good fieldwork is as a learning mechanism. This is a key consideration, particularly as undergraduate field programmes are being reduced in many universities at present.[51]

Fieldwork has been described as being intrinsically about observation and curiosity: it provides students with skills necessary to allow them to begin reading and representing the landscape in various ways (including through use of notes, projections and maps). A recurring key theme in all of the post-fieldwork questionnaires – from all years – is recognition by the

[51] Petcovic, Stokes, and Caulkins, "Geoscientists' perceptions," 7.

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students themselves of the fundamental importance of observation and recording. This allowed them to make good inferences and determinations, which then commonly facilitated an appreciation of the 'bigger picture'.

The previously published trends concerning development of transferable, technical and social skills through first-hand real world fieldwork experiences,[52] were also replicated here in all the post-fieldwork responses. Figures 6 and 7 clearly indicate the importance of the *social* aspects of fieldwork for students: more agreed with the positive aspects of group work, and in trusting fellow student input following fieldwork, and none disagreed after completing the work.

Overall, the student study group demonstrated positive affective domain responses to residential fieldwork prior to departure, and these feelings were further strengthened during and after the field experience. Pre-fieldwork anxiety was felt by some students, but the experience in the field tended to mitigate these concerns. In addition, completion of the work fosters high levels of confidence in the students' ability to meet the challenges of fieldwork, and reinforces their perceptions that fieldwork is an academically valuable learning method. Importantly, *students enjoy fieldwork* and this was consistently evident in the open text answers: they enjoyed the hard work, getting to know each other and the learning experiences encountered, and many of the fourth year students reflected that their fieldwork experiences were among the most important for them.

Fieldwork provides unique opportunities for teaching and learning that are in themselves highly concentrated and focused. As noted earlier, preconceived ideas about the world are pushed and challenged in a field-setting. Students also implicitly require a solid foundation of knowledge and the capacity to organise this in the context of conceptual frameworks. The students must be able to organize and inscribe information and knowledge so that they can quickly access and apply them while working in the field. Finally, by developing "metacognitive" approaches students begin to think as geoscientists.[53]

Geological fieldwork teaches and emphasizes the use of maps, graphics, diagrams and note-taking and direct observation (termed 'portable artefacts' by Brotton[54]) to stimulate insight and develop more robust explanations.

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[52] Ian Fuller et al., "International Perspectives on the Effectiveness of Geography Fieldwork for Learning," *Journal of Geography in Higher Education* 30, no. 1 (2006): 93, https://doi.org/10.1080/03098260500499667.

[53] Mogk and Goodwin, "Learning in the field," 152.

[54] Jeremy Brotton, *A History of the World in Twelve Maps* (London: Penguin Books, 2012).

These data are immutable, replicable and recognizable and they form a scaffold for observation and elucidation. The importance of good observation was noted numerous times by the students, and the significance of physically making the (primary) observation, mark or notation at the study location was a recurring theme in many of the open text answers. The students made these inferences on the value of sound observation, reflecting previous suggestions that such "inscriptions" can be considered as: (1) data and information that can subsequently be transformed (locating direction and angle of dip of rock strata on a map for example) and (2) being *linked to other representations and embedded within new theoretical arguments*.[55,56] Making the first inscription is thus a critical part of the learning process, first-hand field observations are transcribed into recognized symbols and notations that can be used to suggest and interpret larger earth processes. The students learned how to collect field data and then to use these to construct maps, which could subsequently be used, for example, to reconstruct paleoenvironments or interpret various geological processes. While these transformations allow a broader context to develop (e.g. the closure of an ancient ocean through plate tectonic movements – now reflected in rock types and geological structures) the finer observational detail is seen to sit more into the background as the larger story arc is developed. Learning about the world using inscriptions from regional-scale geology maps, for example, is not the same as making the primary observations, recording the data on (large-scale) maps and in notebooks, and developing the subsequent narrative in the field: the students repeatedly noted how their own data and observations and the resultant maps and inscriptions made much more sense than any maps or graphics either shown in lectures or reviewed in texts.

While it was beyond the scope of the present work to explore the impacts in the cognitive domain, it can be argued that the positive affective responses recorded here may provide associated or 'knock-on' impacts elsewhere, and may thus encourage student engagement with the specific (and wider) curriculum. Students gain confidence both as part of and from within their class, and there is clearly potential for them to benefit from the immersive learning environment.

Learning in the field and undertaking fieldwork taps into the various spatial and temporal reasoning "ways of knowing". It also enhances cognitive, technical, social skill development, attitudes and values, and team/group practices. Students build up their experiences in the field, working alone and

[55] Kim Kastens et al., "How geoscientists think and learn," 266.

[56] Mogk and Goodwin, "Learning in the field," 147.

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in teams, and can systematically add to their store of knowledge that can subsequently be accessed for comparative purposes with newly acquired information. Many of the open text answers expressed an appreciation for the sense of scientific rigor which fieldwork afforded, which could then be applied to *all* areas of learning. Students become more capable and confident in cross-integrating knowledge, skills and routines from various courses and modules.

Perhaps more importantly, as the students learn how to transform data, observations and information into knowledge and interpretations, they themselves become transformed as individuals. Numerous references that could be aligned to threshold concepts were referred to on the questionnaires, for example: *"making sense of what I've learned in class"* (EOS3_21) and *"it's explained so much to me"* (EOS2_11).

The students were able to transform their data and observations into more detailed and more complete interpretations: so, they become not only knowledge recipients, but also knowledge generators.[57]

The findings from this study largely mirror those of Boyle et al.[58] However, there are some key differences: the study cohort in the earlier work was drawn from 11 higher education institutes and there were a number of researchers involved. The study presented here examined a smaller student cohort drawn from a single academic discipline in one higher education institute, with only two researchers involved. This does raise issues regarding the insider researcher dilemma. However, the researchers in this instance were at pains to ensure the fairness and the integrity of the process for the students involved; the aim was to become risk-aware rather than risk-averse, given that insider research can potentially tap into rich vein of data.[59]

While the findings of this research are broadly similar to those in Boyle et al., there are some important differences: fewer students (in this study) were concerned or worried and none expressed a desire not to go on the fieldwork. In the post-fieldwork responses in this study, the negative feelings were minimal, while the positive feelings largely matched the findings from Boyle et al.[60] This contrast is more marked in relation to how the students indicated their feelings towards a series of field activities. While the positive responses in both studies are largely similar, a significant difference is evident in the negative responses, which are all below 10 percent in the

[57] de Loë et al., "From Government to Governance," 26.
[58] Boyle et al., "Fieldwork is Good," 315.
[59] Humphrey, "Dilemmas in doing insider research," 582.
[60] Boyle et al., "Fieldwork is Good," 306.

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current study and recorded only in three categories: working outdoors, sharing a room (both of which reduced post-fieldwork) and on the academic demands (two percent post-fieldwork).

The findings in relation to the analysis of knowledge and usefulness questions produced largely similar responses, with the results from this study scoring mean values between 4 and 5 for knowledge – the highest being 4.97 and the lowest being 4.41. The usefulness questions followed a similar trend: this study returned values ranging from 1.43 to 4.92. The key point to note here concerns the question relating to spending time in the library rather than in the field (Table 3, no. 5) the mean scores in this study were 2.10 pre-fieldwork and 1.43 post-fieldwork.

While a small number of students expressed some concerns, these reservations were not expressed as anxiety or a desire to not attend. One significant theme that emerged across the entire cohort in this study was the importance of the student group or class – this was echoed in many responses and in the importance placed on collaboration and sharing of information and data.

As well as eliciting positive affective responses across the three student cohorts, completing the fieldwork helped boost the affective responses of all groups, suggesting that it is at least partially equitable. However, other aspects of equity – disability, inclusiveness, for example – were not investigated in this study. The fieldwork courses examined herein are only available to students who have already declared an interest in pursuing a geoscience-themed degree pathway, and it would be of interest to explore if equity issues were part of that decision making process. This is an area requiring more research particularly in reference to the impression that fieldwork requires a certain level of physical fitness and capability.[61]

The findings of this investigation very clearly support the contention that fieldwork has positive impacts on the affective domain of students. Negative responses were reduced in *all* of the aspects being examined; however, while the field-learning experience appeared to successfully ameliorate any lingering concerns, this improvement should not be taken for granted. In both pre- and post-fieldwork questionnaires, one student (Figures 6 and 7) suggested that they would not recommend fieldwork to other students. However, this student's other responses were broadly positive (or neutral) suggesting they had gained intellectually from the experience, but for reasons unclear would simply not recommend it to others. This might suggest that sufficient information about the nature of the fieldwork course was not

[61] Fuller et al., "International Perspectives," 96.

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presented ahead of the trip. Pre-fieldwork preparations tend to be logistically focused (in terms of physical planning, trip timetable and structure, general health and safety concerns etc.) but there is perhaps the need to address other areas (such as anxiety) which are common areas of student concern more directly. Peer guidance and support could be especially effective in this respect, with more senior (and field-experienced) students invited to discuss details of the planned work and the relay their own personal field-learning experiences with their more junior colleagues. Following on from this work, the researchers have introduced a scheme whereby fourth (final) year students are invited to brief the third year class cohort, and third year students brief the second year cohort. These information sessions are in addition to the usual briefings and documentation provided by academic staff.

This current study had similar outcomes to informal feedback taken by several other higher education programmes[62] and reflects discussions with coordinators of an undergraduate US university residential field course run in Ireland each year.[63]

VIII. **Conclusions and recommendations**

The findings of this research clearly show that fieldwork in geoscience provides a productive and immensely beneficial learning environment for undergraduate students, generating positive affective responses. It has tremendous capacity to positively impact the affective domain: students feel part of a coherent class, their academic and social confidence is enhanced, they develop problem-solving skillsets and they appreciate the value and benefits of teamwork – all graduate attributes that are desirable and beneficial in the post-university workplace. Students also benefit from the situated learning environment and begin to feel part of a larger learning and work community. Academic engagement is stimulated and encouraged and this may then feed into student retention. Fieldwork profoundly changes students: it helps acquaint them better with their classmates and teachers, it provides confidence in their own skills and abilities, and it affords them the opportunity to direct their own learning. Fieldwork provides opportunities for peer-to-peer learning, shoulder-to-shoulder teaching and learning for informal reinforcement. It also offers opportunities for students to work in groups and to lead and direct the work. Fieldwork also presents numerous opportunities

[62] Whitmeyer et al., "Why Ireland."

[63] Whitmeyer, *personal communication*, conversations during fieldwork, June 2017.

for students to cross thresholds of knowledge and learning. These benefits were seen across the entire student cohort investigated in this study, and no gender group appears to have been more advantaged or disadvantaged in this respect. The immersive approach allows students to apply shallow, deep and strategic learning skills and the students themselves are exposed to a multi-stranded, resource-based pedagogy.[64,65]

The following are some recommendations for further work and reflection based on this research reported herein:

- This approach might prove a useful exercise to be repeated annually within academic disciplines as a means of monitoring student engagement, concerns and responses. We would thus recommend that data collection be overseen by someone not known to the students, perhaps a colleague from a cognate discipline (which is similarly engaged in field-based teaching and learning) to reduce the risks posed by the insider researcher dilemma.

- This study has proven useful in gauging the impact on the affective domain and this has to be considered within the broader context of the student experience, specifically with regards student engagement and retention and – critically – in the context of offering the student the best opportunity to bloom.

- The results of this study suggest that fieldwork provides a formative experience for students and an opportunity for immersive learning and learning opportunities that the classroom struggles to replicate. Research approaches like this are required to provide a rational basis for arguing the need to retain fieldwork courses, which can unequivocally demonstrate proven pedagogical (and social) benefits. On this basis, it would be strategically useful to repeat this exercise across a number of cognate geoscience disciplines in different higher education institutes, either on a national or international level.

- It would be interesting to explore if equity issues (disability, inclusiveness, for example) formed a significant part of the student

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[64] Matthew Lancellotti, Sunil Thomas, and Chiranjeev Kohli, "Online video modules for improvement in student learning," *Journal of Education for Business* 91, no. 1 (Spring 2016): 22, https://doi.org/10.1080/08832323.2015.1108281.

[65] Yvonne Turner, "Last orders for the lecture theatre? Exploring blended learning approaches and accessibility for full-time international students," *The International Journal of Management Education* 13, no 2 (July 2015): 168, https://doi.org/10.1016/j.ijme.2015.04.001.

decision-making process about selecting courses with a strong fieldwork component.

- While there were very limited negative responses recorded in this study, they do highlight the importance of good communication in advance of departure on fieldwork courses, and the need for providing students with as much information as possible in a timely manner. It also suggests that peer-to-peer engagement might be useful, where senior class cohorts could discuss fieldwork with junior cohorts (providing an additional source of information and advice).

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