Written evidence submitted by the Field Studies Council (GAP0019)

1. The Field Studies Council (FSC) is a pioneering education charity committed to bringing environmental understanding to all. FSC provides opportunities for people of all ages and abilities to discover, explore, and understand the natural and built environment.

2. We currently welcome 154,000 visitors every year on courses to our UK network of 20 Field Centres. These include groups from nearly 3,000 schools, colleges and over 60 universities (including 23 out of 24 Russell Group universities) who come to study STEM subject degrees or curriculum courses such as biology, geography and geology.

3. With over 70 years of experience, FSC is the UK’s leading provider of biodiversity and ecology related training courses for adult learners, with career development for professionals involved in ecology, natural history and landscape related disciplines. This includes highly specialist courses in biological identification and recording.

4. This submission is based on the insights of experienced teaching staff and visiting staff who have observed first hand the significant changes in levels of STEM skill abilities over an extended period of time in the students undertaking a wide range of courses with FSC. The broad areas of concern are that students are lacking in
   - Report writing skills
   - Investigative skills
   - Maths skills (including having a fear of numbers)
   - The building blocks of understanding the structure and function of organisms
   - The knowledge and / or confidence to find out and put time into scientific discovery.

The STEM skills that were needed but were found to be in short supply or missing

5. Scientific inquiry skills are considered to be lacking including the ability to design scientific tests and deal with the resulting complex, real world, messy data - skills that are needed in areas as diverse as designing new drugs to understanding the impacts of climate change. Staff at FSC have expressed concerns that students do not get a chance to do real science any more. Students may be getting more practical work at A-level as the result of the last change in the curricula (although this still has to be shown) but the practical work risks being ‘about science’ rather than doing science itself.
6. The experiments that students undertake can be more about demonstrating concepts rather than doing science. The results they will get are known to them before they start, an approach encouraged by the need to set lesson objectives in advance. This is not the same as producing real scientists, designing and carrying out experiments where the results are not known in advance. We run the risk of producing people fearful of experimentation as they might ‘get it wrong’. We need to encourage people to explore what they do not know, challenge the expected and develop the skills to explain the unexpected and explore further.

7. Practicals in laboratories where controls are set up and the results are predictable (eg some chemistry experiments) are very different to the scientific investigation skills needed to investigate the real world or analyse complex biological and ecological systems where experimental controls cannot be set up. FSC teaching staff have commented that even students on our MSc courses in Biological Recording have little experience in the importance of data sampling methods to try to analyse complex, chaotic systems. However, it is these STEM skills that are developed by going through the proper scientific process, which are lacking.

8. STEM students need to know what to do when data does not produce the expected results. If the answer is known in advance, there is no need to learn how to modify hypotheses, introduce better controls and replication or even just accept that there was an error. Being able to deal with stochastic environments and the data they produce are key STEM skills that are lacking at the current time. Bringing back an element of real exploratory science over an extended time period would be a good start to reverse this trend. FSC is well placed to do this through its practical approach to field skills.

9. The need for more rigorous information surrounding the levels of practical skills gained by A level science students entering universities has led OFQUAL to set up a research project where 1st year undergraduates studying science undertake the Practical Skills Measure (a series of six practical tests within a 1.5 hour period). Early trials suggested that the ‘field skills’ task was particularly demanding for students.
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10. Whilst FSC welcomes the inclusion of fieldwork as a core element of some GCSE and A level subjects, long term studies of the time spent by school groups on FSC fieldtrips has shown a steady decline, both in terms of the length of residential stays and distance travelled; on average, A level biology groups stayed for 3.08 days and travelled 118kms in 2016, compared to 5.01 days and 182kms in 2004.

11. It takes time to develop good fieldwork skills and the critical thinking ability that goes with them. Shorter field trips mean less time to develop STEM skills such as experiment design and re-design, practical experimentation and analysis. Similarly, shortened distances reduce opportunities to explore and be inspired by a range of novel and contrasting habitats and sites. For some science students the biology A level field course will be their only opportunity to be involved in such fieldwork throughout their whole formal science education, from 5-18 years.

12. Experienced teaching staff have seen a “pushing up” of certain STEM skills so that skills once taught at A-level are now taught at degree level instead and once standard undergraduate skills are missing and can only be developed at master’s level. Employers who expect graduates to have certain STEM skills now cannot assume that that is the case.

13. Teaching staff have commented on the lack of ability that students have to improvise kinaesthetically in terms of modifying or changing equipment to answer specific questions, especially those questions that come as a result of the experiments where the results are not known in advance. Skills and confidence in manipulating and using scientific equipment – this includes field equipment not just lab equipment - are low across all age ranges in secondary schools.

14. The new A level science practical specifications have given teachers greater freedom, but in delivering teacher training, FSC has found that many teachers lack the confidence to use this new freedom within and outside the classroom because their own science education was more based on following experiments like a recipe, rather than genuine scientific experimentation.
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15. Biological identification and recording skills are becoming rare at graduate level. However the data that such experts collect provide the government with key biodiversity indicators for example, the ability to identify bumblebee species provides the essential information needed to ensure levels of crop pollinators, recording first flower dates tracks climate change, identifying rare species protects SSSIs. As a result of a mistaken belief that ‘identification’ skills do not score highly in Bloom’s taxonomy of learning, they have become less prominent. Biological taxonomy skills are not low level cognitive skills but require higher levels of ability including critical analysis of complex data, reading a landscape, logical thought processes and evaluating large amounts of information from different sources. These STEM skills remain essential for identifying indicator species as well as identifying new ones that may have a host of benefits including medicinal ones.

Other Experiences of Skills Programmes

16. Digital learning has a huge potential to enhance STEM skills – for example data capture and analysis of results in real time whilst still in the field can allow learners to check for obvious errors or gaps in the data set before getting back to the laboratory or classroom. This helps develop creative and problem solving skills in overcoming the practical difficulties of doing real science in the real world.

17. Access to big data sets also enhances STEM skills. For example, in outdoor learning it allows data from a series of contrasting locations or environments or data changes over a long period of time to be studied. Big data allows learners to ask bigger questions and put together and incorporate more complex data from multiple data sets beyond the usual scope of what can be collected on one trip in one location. There is an opportunity to use the data and the consequent learning to move subjects and knowledge forward from the original starting point in a textbook.

Conclusions and recommendations

18. The Science and Technology Committee last looked at the issue of field trips in 2011 in its report ‘Practical experiments in school science lessons and science field trips’. The essential contribution that learning outside the classroom makes to a good quality science education was acknowledged. With outdoor learning opportunities being under threat,
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FSC recommends to this committee revisits the importance of outdoor learning and its particular role in developing STEM skills needed to understand a complex and changing environment.

19. As newly qualified science teachers may not have had a significant grounding in practical science from their own education, particularly in outdoor settings, we suggest that the committee investigate whether current teacher training provides enough opportunities to develop STEM skills, confidence and knowledge to enable teachers to deliver first class practical and outdoor science education that reflects the complexities of the real world.

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