Increasing effectiveness in whole-of-curriculum field-based work-integrated learning of the natural environment for improved employability

An Australian Technology Network of Universities: Learning and Teaching Excellence Project

Final Report: February 2019

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Achievement statement

Increasing effectiveness in whole-of-curriculum field-based work-integrated learning of the natural environment for improved employability

About

Led by Curtin University, in partnership with the University of South Australia and Queensland University of Technology with the support of the Australian Council of Environmental Deans and Directors, this project ran from June 2018 to February 2019.

Project Aim

The goal was to investigate whether field-based units in the earth and environmental sciences provide an opportunity for students to develop and practice employability skills?

Project Output

A mapping tool was produced to investigate where in the curriculum employability skills were developed and assessed. Examples of the way in which technical, communication and project management skills are integrated into field-based units are also presented.

Project Conclusion.

The project concluded that field-based units in the earth and environmental sciences can be adapted to meet the requirements of institutional work integrated learning policy.

Executive Summary

Increasing effectiveness in whole-of-curriculum field-based work-integrated learning of the natural environment for improved employability is an Australian Technology Network of Universities (ATN) Excellence in Learning and Teaching pilot project led by Curtin University of Technology, with the University of South Australia and Queensland University of Technology and supported by the Australian Council of Environmental Deans and Directors.

The project focused on identifying the employability skills developed in field-based units delivered in undergraduate earth and environmental science programs in response to the demands for the tertiary education sector to provide graduates with improved employability skills through an industry relevant curriculum (Universities Australia, 2008).

The project aimed to investigate whether traditional field-based units in earth and environmental science programs could be delivered in a way that meets the requirements of institutions to incorporate work integrated learning. A core element of the project was the design of a curriculum mapping tool to identify where in the curriculum employability skills are taught and assessed. The project also aimed to identify examples of good pedagogical practice to develop students' ability to adapt to changing technologies, communication and project planning (TCPP) skills in field-based units.

The project used interviews and workshops with academic staff to answer the following research questions: 1) Do current field-based courses in the earth and environmental sciences provide an opportunity for students to develop and practice employability skills? 2) Is it possible to design a curriculum mapping tool that identifies gaps in content and assessment of employability skills? and 3) How is it best to integrate TCPP into individual units?

The project produced three outcomes: 1) A curriculum mapping tool; 2) exemplars of approaches taken to embed TCPP skills in field-based undergraduate units; and 3) an understanding of the processes required to inform whole-of-curriculum development to ensure graduates are work-ready.

The most significant finding of the project was that field-based units can be designed to meet the needs of WIL. It also found that fieldwork is considered essential for preparing students for the workplace, but it is expensive, risky and for these reasons not supported in some institutions.

It is recommended that this pilot study be widened to include a wider group of earth and environmental science programs in order to further develop the curriculum mapping tool for application to the whole curriculum and to refine the content and assessment of field-based units. Industry participation should be encouraged in the design and delivery of the units and further investigation of the way to achieve a whole-of-curriculum outcome for integration of TCPP for field programs in the natural environment. Such a project should also develop and deliver professional development for coordinators of field-based units

Project Report

Work Integrated Learning (WIL) has attracted attention nationally and internationally as universities investigate ways to improve the work readiness of graduates and an increasing number of Australian universities are developing policies to provide such opportunities to all students (Ferns, Smith et al. 2014, Peach, Moore et al. 2015, Universities Australia 2015)

This pilot project was conceived to investigate whether field-based units can be delivered in a way that meets the requirements of WIL both to meet the needs of institutions to incorporate WIL and the belief of earth and environmental science academics who strongly hold the view that field work is an essential part of the curriculum (Scott, Goulder et al. 2012).

Project aim and outcomes

This project aims to deliver two outputs that will facilitate a network of practice between universities and industry through shared engagement of a whole-of-curriculum process that aids development of a program that meets the needs of employers for work-ready graduates.

Output 1. A **curriculum mapping tool** to identify relevant work-integrated learning content and gaps in existing field-based units in earth and environmental sciences with respect to 'ability to adapt to changing technologies, communication and project planning skills (TCPP).

Output 2. Exemplars of the approaches taken to embed TCPP skills' in field-based undergraduate subjects will be evaluated.

Project approach

This pilot project adopted an exploratory subjectivist approach using interviews and workshops with academic staff to answer the following research questions:

1. Do current field-based courses in the earth and environmental sciences provide an opportunity for students to develop and practice employability skills?
2. Is it possible to design a curriculum mapping tool that can be used to identify gaps in content and assessment of employability skills?
3. How is it best to integrate TCPP into individual units in field programs in the natural environment to achieve most effective environmental science learning outcomes?

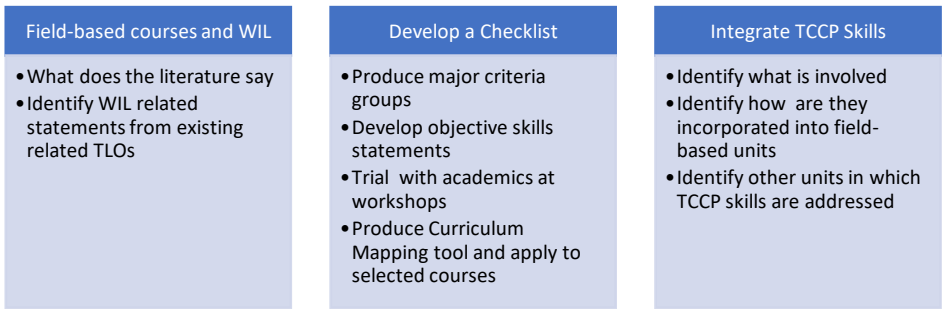

Figure 1. Overview of the project

Project outputs

This pilot project produced three outcomes:

1. A curriculum mapping tool designed to identify work-integrated learning content and assessment gaps in existing field-based units in the natural environment;
2. Exemplars of approaches taken to embed TCPP skills in field-based undergraduate subjects;
3. An understanding of the processes required to inform whole-of-curriculum development to ensure graduates are work-ready.

The curriculum tool was designed to investigate whether individual field-based units delivered a set of employability skills (Smith, Ferns et al. 2014) that would improve graduates' work-readiness. Employability skills relevant to work-integrated learning content have been developed from the published TLOs for Science, Agriculture and Environment, and Environment and Sustainability; the EIANZ Proficiency Matrix for Graduate Environmental Professionals, the AIG National Graduate Group Geoscience Survey (Leigh 2016), the ACEDD Future Employment report (Bruce 2017), and the Victorian Education Department Employability Skills Framework (Department of Education Victoria 2006). A list of more than 40 graduate skills measures related to employment of graduates from environmental sciences was compiled. These were grouped into seven major criteria groups that were used as the starting point for developing the employability skills for the curriculum mapping tool. Each criterion was then broken down into sub-categories (objective statements) which could be used to assess (Bosco and Ferns 2014) whether the skill was taught in the unit being considered (Table 1).

The draft tool was formatted as a five column excel worksheet. The first two columns contain the criteria and sub-criteria. Users input responses to each of the sub-criteria in the third and fourth columns and the fifth column is used to indicate where and how the skill is assessed.

Completion is undertaken by the unit coordinator to produce a 'traffic light' report that provides a visual representation for the unit.

- Red means that the sub-criterion is not met anywhere in the unit
- Yellow means it is partially met in the unit
- Green means it is fully met by the unit

The draft tool was sent to unit coordinators of field-based ecology and geology units at Curtin University and park management and geology units at the University of South Australia prior to workshops where the draft tool was discussed. The workshops also considered appropriate ways in which specific employability skills could be assessed in field-based units and approaches taken to embed 'ability to adapt to changing technologies, communication and project planning skills (TCPP)' in field-based undergraduate subjects.

After the workshops an agreed final version of the tool was completed for five units by the unit coordinator together with the project manager during which further minor modifications were made. The final tool is presented as (Appendix 1).

Table 1. Employability **curriculum mapping tool** criterion groups and sub-category statements

Criterion	Sub-criteria
Communication	Communicate field data and results effectively in ways appropriate to a range of audiences, for a range of purposes, and using a variety of modes.
	Demonstrate methods of effective two-way communication of fieldwork using a range of written, oral and visual means.
Inquiry and Critical Thinking	Design and scope an investigation.
	Identify contemporary issues and opportunities.
	Gather, critically evaluate and synthesise information from a range of relevant sources and disciplines.
Problem Solving	Think creatively to generate innovative solutions.
	Tackle unfamiliar problems.
	Apply logical and rational processes to analyse the components of an issue.
Personal and professional responsibility	Work effectively, responsibly and safely in an individual and team context.
	Lead and influence others.
	Work effectively and inclusively with people from different cultures and backgrounds.
	Act with integrity in all aspects of data collection, processing and reporting.
	Be accountable for their own learning and professional work by: Being independent and self-directed learners.
Ethical Behaviour	Be aware of and work within OHSW and relevant regulatory frameworks.
	Practise ethical conduct.
	Recognise and respect cultural diversity particularly the perspective of Indigenous Australians.
New Technologies	Select and use appropriate technologies recognising their advantages and limitations.
	Assess what information is needed and where it might be found using appropriate emerging and established technologies.
Project Management	Establish and meet clear project goals and deliverables.
	Manage time and priorities- setting time lines, co-ordinating tasks for self & with others.
	Predicting - weighing up risk, evaluate alternatives and apply evaluation criteria.
Discipline Knowledge and field skills	Demonstrate a mastery of discipline specific knowledge by application in field-based settings.
	Operate safely and efficiently in remote field settings.
	Effectively and efficiently collect, record and manage data in the field.
	Operate collaboratively and individually in field conditions.

Findings

Field-based units

During the workshops with unit coordinators and others involved in teaching and planning field-based units the following commonalities were raised. They:

- are commonly included as capstone courses in undergraduate programs in the environmental science;
- are considered an essential part of the preparation of graduates;
- are often undertaken in association with relevant industry groups;
- require considerable planning and preparation;
- are expensive to deliver relative to classroom or laboratory units; and
- involve a range of risks to the participants.

Because of these last two points University Administrators are not always supportive.

Employability curriculum mapping tool

- Unit coordinators saw value in using the tool and felt that as well as including the communication and enterprise skills it was important to include a set of skills related to discipline knowledge and field skills;
- Communication, Problem Solving and Inquiry and Critical Thinking skills are introduced and taught in classroom based-units and are practised rather than taught in field-based units;
- The majority of undergraduate environmental programs have two or more extended field-based units. One in year two and a capstone unit in year three;
- Skills from each of the seven employability criteria are included in most of the field-based units with capstone units requiring application of more discipline specific employability skills;
- Assessment processes for both levels tend to be the same and are biased towards communication skills (field reports, presentations etc.). They rarely require students to reflect on the experience;
- Unit coordinators agreed that consideration should be given to changing assessment methods to incorporate other employability skills;

Technology, Communication and Project Planning

The Bruce report (Bruce 2018) identified three sets of skills, in addition to subject knowledge, that employers' value in new graduates: the ability to adapt to changing technologies; communication skills and project planning skills (TCPP). These have been elaborated in the curriculum mapping tool that was developed to map the way in which these skills are incorporated into selected fieldwork courses. The results show that students are required to demonstrate a range of communication skills and that successful fieldwork projects require good project management. The pedagogy for achieving this is widely understood and the development and assessment of the skills takes place throughout a student's undergraduate program. Helping students adapt to changing technologies is not as easily done. The range of technologies is broad and constantly changing. Some technologies are easily incorporated into courses, others are too expensive or require specialist equipment and training. An example is the way in which new technologies have been incorporated into a field-based unit. ENVT 3030 – Environmental and Geospatial Field Project is a capstone unit in the Environmental Science program at the University of South Australia. It is a

project-based course that provides students with the opportunity to gain experience and demonstrate proficiency in applying relevant concepts and skills learned earlier in the program. Students work in teams on field-based projects that cover a range of different areas including National Parks and private conservation areas. The projects are developed with the agency staff and involve real issues that present significant challenges. Students work collaboratively in a team with real data and develop a proposal to solve a real-world problem. The outcomes are a report and a formal presentation to the agency.

The field project is designed to hone professional abilities and develop a realistic approach to problem-solving in teams in which the members have a diversity of skills and knowledge. The teams are encouraged to use modern technologies including GIS, drones, remote sensing tools and communication technologies to develop aspects of the project. An example of the output of a group that participated in the 2018 field study that was undertaken for Nature Foundation SA at their Hiltaba Nature Reserve is summarised below. Each member of the group brought different skills to the solution of the problem/task that they were set. To practice teamwork skills each student was required to lead their team for an aspect of the project. Project Management skills were required to scope, design, develop a budget, and implement the project; communication skills were required in liaising with the agency and in report preparation and preparation; and the projects required selection and incorporation of appropriate technologies.

For one of the projects a group prepared a downloadable interactive map with links to individual walking trails and scenic points (https://arcg.is/04O9W1). They also derived a digital elevation model to produce a viewshed analysis layer that shows the region that can be seen from particular points enabling selection of the best vantage points to view a particular feature. They also used GIS and remote sensing to develop a Network Analysis Cost Layer that depicts degree of difficulty of vehicle travel over the terrain and could be used by agency staff to determine the most efficient travel route for an emergency evacuation. This technology was also applied to develop a layer that showed the parts of the property most likely to host feral goats.

Another example of the way in which emerging technologies are incorporated into unit delivery of Project Live at UniSA (http://projectlive.org.au/index.html). It is a cross-disciplinary initiative at the University of South Australia that uses immersive visualisation technologies to create flexible, interactive and engaging experiential learning exercises. It presents a portfolio of immersive digital visualisations that are used for teaching in classrooms and for preparing students for fieldwork. The resources are used with a broad range of students studying geoscience, environmental management, surveying, and construction management. Virtual tours and reconstructions with an emphasis on ground- and drone-based 3D photogrammetry for mapping applications are used in undergraduate geoscience classes to complement and augment field experiences. In other courses virtual reality is used to investigate the benefits derived from green space, to improve bushfire preparation and understanding of evacuation triggers for residents of bushfire susceptible regions, and to build capacity in tertiary students to improve environmental planning. Virtual- and augmented-reality materials are used to teach construction management students about human factors in construction, construction safety, built environment user experience, and sustainability in the built environment.

Future recommendations

This pilot project has demonstrated that it is possible for field-based units in the earth and environmental sciences to be developed and delivered in a way that provides an opportunity for students to develop and practice employability skills. It is recommended that a larger project be undertaken involving a wider group of earth and environmental science programs to incorporate the following actions:

Development of the Curriculum Mapping tool

- The tool should be refined by applying it to a wider set of field-based units from the natural and environmental sciences;
- The tool should be further developed in a way that its completion for all courses in a program automatically develops a whole of program report (Botwright Acuna, Kelder et al. 2014).

Design and delivery of field-based units

- Industry participation in field-unit design and delivery.
- Develop methods to incorporate assessment of employability skills in field-based units

Integration of TCPP

- Investigate the most effective way to integrate TCPP across years and semesters to achieve an improved whole-of-curriculum outcome for graduates of environmental science?
- How is it best to achieve a whole-of-curriculum outcome for integration of TCPP for field programs in the natural environment?

Professional development of academic staff

- Plan professional development for educators to improve the design and delivery of field-based units.

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Appendix 1. Curriculum Mapping Tool

Unit Report	**BOTA2000 Plant Diversity and Adaptation**		
Criterion Statements	**Students who complete this unit satisfactorily will**	**Is criterion practised**	**Is criterion assessed**
Communication	Communicate scientific results effectively in ways appropriate to a range of audiences, for a range of purposes, and using a variety of modes.		
	Demonstrate methods of effective two-way communication using a range of written, oral and visual means.		
Inquiry & Critical Thinking	Design and plan an investigation.		
	Identify contemporary issues and opportunities		
	Gather, critically evaluate and synthesise information from a range of relevant sources and disciplines		
Problem Solving	Think creatively to generate innovative solutions.		
	Tackle unfamiliar problems		
	Apply logical and rational processes to analyse the components of an issue		
Personal and professional responsibility	Work effectively, responsibly and safely in an individual and team environment.		
	Lead and influence others.		
	Work effectively and inclusively with people from different cultures and backgrounds		

Key	
	Fully covered
	Partially covered
	Not covered

	Recognise and respect cultural diversity particularly the perspective of Indigenous Australians		
	Be accountable for their own learning and professional work by being independent and self-directed learners.		
Ethical behaviour	Demonstrate knowledge of relevant regulatory frameworks		
	Practise ethical conduct.		
New Technologies	Use appropriate technologies recognising their advantages and limitations.		
	Assess what information is needed and where it might be found using appropriate emerging and established technologies.		
Project Management	Establish and meet clear project goals and deliverables		
	Manage time and priorities- setting time lines, co-ordinating tasks for self & with others		
	Predicting - weighing up risk, evaluate alternatives and apply evaluation criteria		
Discipline Knowledge and field skills	Demonstrate a mastery of discipline specific knowledge by application in field-based settings		
	Operate safely and efficiently in remote field settings		
	Effectively and efficiently collect, record and manage data in the field		
	Operate collaboratively and individually in field conditions		

Unit Report	ECEV2000 Terrestrial Ecology		
Criterion Statements	**Students who complete this unit satisfactorily will**	**Is criterion taught**	**Is criterion assessed**
Communication	Communicate field data and results effectively in ways appropriate to a range of audiences, for a range of purposes, and using a variety of modes.		
	Demonstrate methods of effective two-way communication of fieldwork using a range of written, oral and visual means.		
Inquiry & Critical Thinking	Design and plan an investigation.		
	Identify contemporary issues and opportunities		
	Gather, critically evaluate and synthesise information from a range of relevant sources and disciplines		
Problem Solving	Think creatively to generate innovative solutions.		
	Tackle unfamiliar problems		
	Apply logical and rational processes to analyse the components of an issue		
Personal and professional responsibility	Work effectively, responsibly and safely in an individual and team environment.		
	Lead and influence others.		
	Work effectively and inclusively with people from different cultures and backgrounds.		
	Recognise and respect cultural diversity particularly the perspective of Indigenous Australians.		
	Act with integrity in all aspects of data collection, processing and reporting.		
	Be accountable for their own learning and professional work by being independent and self-directed learners.		

Key	
	Fully covered
	Partially covered
	Not covered

Ethical behaviour	Demonstrate knowledge of relevant regulatory frameworks.		
	Practise ethical conduct.		
New Technologies	Use appropriate technologies recognising their advantages and limitations.		
	Assess what information is needed and where it might be found using appropriate emerging and established technologies.		
Project Management	Establish and meet clear project goals and deliverables		
	Manage time and priorities- setting time lines, co-ordinating tasks for self & with others		
	Predicting - weighing up risk, evaluate alternatives and apply evaluation criteria		
Discipline Knowledge and field skills	Demonstrate a mastery of discipline specific knowledge by application in field-based settings		
	Operate safely and efficiently in remote field settings		
	Effectively and efficiently collect, record and manage data in the field		
	Operate collaboratively and individually in field conditions		

Unit Report	ECEV 3001 Terrestrial & Marine Science Project		
Criterion Statements	**Students who complete this unit satisfactorily will**	**Is criterion taught**	**Is criterion assessed**
Communication	Communicate field data and results effectively in ways appropriate to a range of audiences, for a range of purposes, and using a variety of modes.		
	Demonstrate methods of effective two-way communication of fieldwork using a range of written, oral and visual means.		
Inquiry & Critical Thinking	Design and plan an investigation.		
	Identify contemporary issues and opportunities		
	Gather, critically evaluate and synthesise information from a range of relevant sources and disciplines		
Problem Solving	Think creatively to generate innovative solutions.		
	Tackle unfamiliar problems		
	Apply logical and rational processes to analyse the components of an issue		
Personal and professional responsibility	Work effectively, responsibly and safely in an individual and team environment.		
	Lead and influence others.		
	Work effectively and inclusively with people from different cultures and backgrounds.		
	Recognise and respect cultural diversity particularly the perspective of Indigenous Australians.		
	Act with integrity in all aspects of data collection, processing and reporting.		
	Be accountable for their own learning and professional work by being independent and self-directed learners.		

Key	
	Fully covered
	Partially covered
	Not covered

Ethical behaviour	Demonstrate knowledge of relevant regulatory frameworks.		
	Practise ethical conduct.		
New Technologies	Use appropriate technologies recognising their advantages and limitations.		
	Assess what information is needed and where it might be found using appropriate emerging and established technologies.		
Project Management	Establish and meet clear project goals and deliverables		
	Manage time and priorities- setting time lines, co-ordinating tasks for self & with others		
	Predicting - weighing up risk, evaluate alternatives and apply evaluation criteria		
Discipline Knowledge and field skills	Demonstrate a mastery of discipline specific knowledge by application in field-based settings		
	Operate safely and efficiently in remote field settings		
	Effectively and efficiently collect, record and manage data in the field		
	Operate collaboratively and individually in field conditions		

Unit Report	GEOL 2009 Geological Field Mapping		
Criterion Statements	**Students who complete this unit satisfactorily will**	**Is criterion taught**	**Is criterion assessed**
Communication	Communicate field data and results effectively in ways appropriate to a range of audiences, for a range of purposes, and using a variety of modes.		
	Demonstrate methods of effective two-way communication of fieldwork using a range of written, oral and visual means.		
Inquiry & Critical Thinking	Design and plan an investigation.		
	Identify contemporary issues and opportunities		
	Gather, critically evaluate and synthesise information from a range of relevant sources and disciplines		
Problem Solving	Think creatively to generate innovative solutions.		
	Tackle unfamiliar problems		
	Apply logical and rational processes to analyse the components of an issue		
Personal and professional responsibility	Work effectively, responsibly and safely in an individual and team environment.		
	Lead and influence others.		
	Work effectively and inclusively with people from different cultures and backgrounds.		
	Recognise and respect cultural diversity particularly the perspective of Indigenous Australians.		
	Act with integrity in all aspects of data collection, processing and reporting.		
	Be accountable for their own learning and professional work by being independent and self-directed learners.		

Key	
	Fully covered
	Partially covered
	Not covered

Ethical behaviour	Demonstrate knowledge of relevant regulatory frameworks.		
	Practise ethical conduct.		
New Technologies	Use appropriate technologies recognising their advantages and limitations.		
	Assess what information is needed and where it might be found using appropriate emerging and established technologies.		
Project Management	Establish and meet clear project goals and deliverables		
	Manage time and priorities- setting time lines, co-ordinating tasks for self & with others		
	Predicting - weighing up risk, evaluate alternatives and apply evaluation criteria		
Discipline Knowledge and field skills	Demonstrate a mastery of discipline specific knowledge by application in field-based settings		
	Operate safely and efficiently in remote field settings		
	Effectively and efficiently collect, record and manage data in the field		
	Operate collaboratively and individually in field conditions		

Unit Report	GEOL 4000 Minerals Geoscience/GEOL 4001 Geoscience Analytical Techniques		
Criterion Statements	**Students who complete this unit satisfactorily will**	**Is criterion taught**	**Is criterion assessed**
Communication	Communicate field data and results effectively in ways appropriate to a range of audiences, for a range of purposes, and using a variety of modes.		
	Demonstrate methods of effective two-way communication of fieldwork using a range of written, oral and visual means.		
Inquiry & Critical Thinking	Design and plan an investigation.		
	Identify contemporary issues and opportunities		
	Gather, critically evaluate and synthesise information from a range of relevant sources and disciplines		
Problem Solving	Think creatively to generate innovative solutions.		
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Personal and professional responsibility	Work effectively, responsibly and safely in an individual and team environment.		
	Lead and influence others.		
	Work effectively and inclusively with people from different cultures and backgrounds.		
	Recognise and respect cultural diversity particularly the perspective of Indigenous Australians.		
	Act with integrity in all aspects of data collection, processing and reporting.		
	Be accountable for their own learning and professional work by being independent and self-directed learners.		

Key	
	Fully covered
	Partially covered
	Not covered
	Pre-requisite knowledge

Ethical behaviour	Demonstrate knowledge of relevant regulatory frameworks.		
	Practise ethical conduct.		
New Technologies	Use appropriate technologies recognising their advantages and limitations.		
	Assess what information is needed and where it might be found using appropriate emerging and established technologies.		
Project Management	Establish and meet clear project goals and deliverables		
	Manage time and priorities- setting time lines, co-ordinating tasks for self & with others		
	Predicting - weighing up risk, evaluate alternatives and apply evaluation criteria		
Discipline Knowledge and field skills	Demonstrate a mastery of discipline specific knowledge by application in field-based settings		
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	Effectively and efficiently collect, record and manage data in the field		
	Operate collaboratively and individually in field conditions		