SUPPLEMENTARY MATERIAL

Chapple, D.G., Wilson, L., Herbert, R.I., San Martin, R., Weir, B., & Ho, S. (2022). Do students value on-campus field-based education? A case study of science educational initiatives in the Jock Marshall Reserve. *International Journal of Innovation in Science and Mathematics Education, 30*(2), 29-45.

Supplementary Methods

The Jock Marshall Reserve (JMR)

The JMR is a 3-hectare bushland reserve (including a 0.2 ha lake, associated wetland, and 2 sampling piers), and a premier learning space, at Monash University's Clayton campus (Melbourne, Australia). Undergraduate students from first, second and third year participate in a diversity of applied and experiential learning activities related to biological and environmental science in the reserve. The reserve is also available for use to biological honours and Masters students, though they comprise a relatively smaller proportion of users and were therefore not included as a focal group in this survey. Over the last twenty years, thousands of undergraduates have undertaken educational programs in this outdoor learning space. Experiences at the JMR generally aim to enhance skills development, deepen understanding of concepts, and boost graduate employability by enabling authentic 'real-world' environmental and ecological experiential learning involving the practical application of theory. For this reason, the reserve supports cross-disciplinary spatial and temporal examinations of biodiversity, soil, weather and water, and experiential, problem- and inquiry-based pedagogy. For example, students in an environmental monitoring unit design and conduct their own sampling programs using state and national environmental monitoring guidelines. Such experiences aim to enrich undergraduate studies by complementing traditional learning approaches. The JMR creates opportunities for students to develop the practical and professional skills required for a career in scientific research, environmental governance and consultancy, or sustainability. Informal feedback to date already suggests students do value their studies at the JMR. This aligns with some previous studies of undergraduate students, both in science and other domains (Cotton & Cotton, 2009; Goulder et al., 2013). However, little research has been undertaken to formally evaluate and investigate student perceptions of on-campus fieldwork at the JMR.

Educational Technologies at the JMR

Through time, the reserve has undergone multiple educational enhancements to boost the authenticity and effectiveness of learning experiences. The innovations feature technologies that reflect industry practice and facilitate flexibility, active learning, social learning, and professional practice (e.g. Chapple et al., 2017). Few studies have examined student views on educational technologies within fieldwork experiences (Thomas & Munge, 2017).

The JMR Education Project formally commenced in 2013, and involved several key elements to reflect professional methods and approaches in environmental science. The following technologies and infrastructure were integrated into the learning environment and learning activities to reflect and create access to remote monitoring practices used in a range of environmental professional sectors such as consultancy and government:

1) Development of a cross-platform (desktop PC, mobile devices) website (http://jockmarshallreserve.com.au/) to showcase the JMR, host our educational content, and provide a hub for students to access the JMR Lake cameras and environmental monitoring systems. Quick-response (QR) codes were developed and placed around the reserve, to enable students to have quick and easy access to the relevant sections of the website (for further information see Chapple et al., 2017).

2) An array of water quality data loggers were established in the JMR Lake (http://jockmarshallreserve.com.au/monitoring/), along with a weather station, to allow students to conduct industry standard environmental monitoring and data quality.
3) The IT and Wi-Fi network in the reserve were upgraded to better enable students to access the resources listed above.
4) Improved signage and pathways within the JMR.
5) Construction of a dedicated classroom (Environmental Lab; ~112 seat capacity) within the JMR.
6) Incorporation of the above elements into the units taught in the JMR, including the revision and modification of existing pedagogical approaches, revision of existing, or development of new, practical classes, and updated assessments. Specifically, this included:
    a. Students in BIO2040 Conservation Biology conducting waterbird surveys of the JMR lake using two methods. First they completed a traditional on-site survey during the scheduled practical class. Then in their own time, they completed another survey remotely through the JMR website, using the cameras positioned around the lake. Students were asked to compare the pros and cons of on-site vs remote waterbird surveys.
    b. Integrating QR codes into our annual lizard survey in the reserve for BIO3132 Biology of Australian Vertebrates (Chapple et al. 2017). Students scan the QR codes, positioned at each survey transect in the reserve, with their smartphones to access the online resources on the JMR website. These resources included information about the practical, photos and details of the transects, and a lizard identification guide (e.g., http://jockmarshallreserve.com.au/lizard-species-list/). Through a collaboration with the Atlas of Living Australia (ALA; http://www.ala.org.au/), our webpage links directly with their extensive database and allows students to get detailed information about animals that they identify.
    c. Demonstrating to students in ENV2022 Environmental Analysis the value of long-term datasets for understanding natural temporal (diurnal, weekly and seasonal) and spatial (vertical stratification or patchy habitat) fluctuations in water chemistry (e.g., pH, electrical conductivity, temp, dissolved oxygen, turbidity) and climate (e.g., temp). The environmental data loggers and weather station allow students to complete real-world, industry standard environmental monitoring at the JMR. In addition to their own data collected on-site, the students use the JMR website interface to monitor data in real-time (every 30 min), and download long term data (months or years). As part of their practical classes they analyse, in collaboration with industry partners (e.g. Melbourne Water), fine-scale temporal and spatial variations in physicochemical parameters and relate these to biological indicators of wetland health (e.g., the diversity, distribution and abundance of water plants and animals including aquatic macroinvertebrates, frogs and water birds).

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Supplementary Results

Table S1: Student perceptions of the Jock Marshall Reserve activities within the BIO2040 Conservation Biology unit. This table shows the mean and standard error (SE) values for student responses to the statements given below. The Likert-attitude scale used for responses has been quantified as follows: Strongly agree (5), agree (4), neutral (3), disagree (2) and strongly disagree (1). The percentage (%) of participants who selected either agree or strongly agree is also shown. (n=45)

Likert-attitude Scale Question/Statement	Mean ± SE	Percentage of Agreeance (%)
The data I collected at the JMR helped me better understand biological data	4.16 ± 0.12	91%
The learning in this unit was more authentic because of the activities at the JMR	4.16 ±0.13	84%
I learnt practical skills in conservation biology during fieldwork at the JMR	4.11 ±0.14	84%
The activities at the JMR helped me address the unit learning outcomes	4.00 ±0.13	84%
I valued the opportunity to practice professional sampling techniques using equipment	4.22 ± 0.14	82%
The assessments were more engaging because of the activities at the JMR	4.00 ± 0.17	78%
The teaching was more engaging because of the activities at the JMR	3.76 ± 0.16	64%
I believe the activities at the JMR will increase my employability	3.53 ±0.14	49%
The practical activities at the JMR were the most valuable element of this unit *****	3.07 ± 0.14	33%
This unit would have been of a similar quality without any activities in the JMR	2.76 ± 0.16	24%
I see no educational value in using the JMR in this unit	1.82 ± 0.15	11%

** Significant difference (chi-sq.= 8.37, df= 1, p<<0.05) between males (μ=3.75) and females (μ=2.82)*
*** Percentages have been rounded*

SUPPLEMENTARY MATERIAL

Chapple, D.G., Wilson, L., Herbert, R.I., San Martin, R., Weir, B., & Ho, S. (2022). Do students value on-campus field-based education? A case study of science educational initiatives in the Jock Marshall Reserve. *International Journal of Innovation in Science and Mathematics Education, 30*(2), 29-45.

Table S2: Student perceptions of the Jock Marshall Reserve activities within the BIO3132 Biology of Australian Vertebrates unit. This table shows the mean and standard error (SE) values for student responses to the statements given below. The Likert-attitude scale used for responses has been quantified as follows: Strongly agree (5), agree (4), neutral (3), disagree (2) and strongly disagree (1). The percentage (%) of participants who selected either agree or strongly agree is also shown. (n=23)

Likert-attitude Scale Question/Statement	Mean ± SE	Percentage of Agreeance (%)
The activities at the JMR helped me address the unit learning outcomes	4.65 ± 0.12	96%
I learnt practical skills in biology during fieldwork at the JMR	4.48 ±0.12	96%
The learning in this unit was more authentic because of the activities at the JMR	4.35 ± 0.12	96%
The teaching was more engaging because of the activities at the JMR	4.30 ±0.16	91%
The assessments were more engaging because of the activities at the JMR	4.39 ±0.15	87%
The data I collected at the JMR helped me better understand biological data	4.26 ± 0.14	87%
I valued the opportunity to use technology during fieldwork	4.00 ± 0.18	70%
I believe the activities at the JMR will increase my employability	3.91 ± 0.20	70%
The practical activities at the JMR were the most valuable element of this unit	3.61 ± 0.16	52%
This unit would have been of a similar quality without any activities in the JMR	2.30 ± 0.17	13%
I see no educational value in using the JMR in this unit	1.48 ± 0.19	4%

**Percentages have been rounded*

SUPPLEMENTARY MATERIAL

Chapple, D.G., Wilson, L., Herbert, R.I., San Martin, R., Weir, B., & Ho, S. (2022). Do students value on-campus field-based education? A case study of science educational initiatives in the Jock Marshall Reserve. *International Journal of Innovation in Science and Mathematics Education, 30*(2), 29-45.

Table S3: Student perceptions of the Jock Marshall Reserve activities within the ENV2022 Environmental Sampling and Monitoring unit. This table shows the mean and standard error (SE) values for student responses to the statements given below. The Likert-attitude scale used for responses has been quantified as follows: Strongly agree (5), agree (4), neutral (3), disagree (2) and strongly disagree (1). The percentage (%) of participants who selected either agree or strongly agree is also shown. (n=13)

Likert-attitude Scale Question/Statement	Mean ± SE	Percentage of Agreeance (%)
I learnt practical skills in sampling and monitoring during fieldwork at the JMR	4.92 ±0.08	100%
The activities at the JMR helped me address the unit learning outcomes	4.77 ± 0.12	100%
The monitoring equipment and data I collected at the JMR helped me to better understand environmental data	4.92 ± 0.08	92%
The assessments were more engaging because of the activities at the JMR	4.69 ± 0.17	92%
The teaching was more engaging because of the activities at the JMR	4.62 ± 0.18	92%
I valued using industry/government monitoring practices and equipment	4.54 ± 0.18	92%
The learning in this unit was more authentic because of the activities at the JMR	4.54 ± 0.18	92%
I believe the activities at the JMR will increase my employability	4.38 ± 0.18	92%
The practical activities at the JMR were the most valuable element of this unit	4.31 ± 0.26	85%
This unit would have been of a similar quality without any activities in the JMR	1.38 ± 0.14	0%
I see no educational value in using the JMR in this unit	1.23 ± 0.12	0%

**Percentages have been rounded*

SUPPLEMENTARY MATERIAL

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Table S4: How use of the Jock Marshall Reserve altered students' thinking in regard to the unit BIO2040. This table represents the percentage of students from the unit BIO2040, who mentioned one of the open-coded themes listed below within their open-ended response to the question "*In the unit BIO2040, did your activities at the JMR change your thinking about Conservation Biology?"* (n=45)

Open-coded Theme	**Percentage of Respondents (No. of Students)**
Overall Views of 'Conservation Biology' Didn't Change	40% (18)
Reinforced Understanding of 'Conservation Biology'	24% (11)
Improved Understanding of the Unit's Practical Application	20% (9)
Contextualised Learning in 'Real-world'	20% (9)
Better Understanding of Data Collection and Analysis	11% (5)
Further Understood Complexity of Conservation Biology Fieldwork	11% (5)
Learned Specific Survey and Sampling Techniques	7% (3)

**Percentages have been rounded*

SUPPLEMENTARY MATERIAL

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Table S5: How use of the Jock Marshall Reserve altered students' thinking in regard to the unit BIO3132. This table represents the percentage of students from the unit BIO3132, who mentioned one of the open-coded themes listed below within their open-ended response to the question *"In the unit BIO3132, did your activities at the JMR change your thinking about the biology of Australian Vertebrates"?* (n=23)

Open-coded Theme	**Percentage of Respondents (No. of Students)**
Overall Views of 'Conservation Biology' Didn't Change	57% (13)
Reinforced Understanding of the Biology of 'Australian Vertebrates'	43% (10)
Learned Specific Survey and Sampling Techniques	30% (7)
Improved Understanding of the Unit's Practical Application	13% (3)
Better Understanding of Data Collection and Analysis	13% (3)
Further Understood Complexity of Fieldwork and Research	4% (1)

**Percentages have been rounded*

SUPPLEMENTARY MATERIAL

Chapple, D.G., Wilson, L., Herbert, R.I., San Martin, R., Weir, B., & Ho, S. (2022). Do students value on-campus field-based education? A case study of science educational initiatives in the Jock Marshall Reserve. *International Journal of Innovation in Science and Mathematics Education, 30*(2), 29-45.

Table S6: How use of the Jock Marshall Reserve altered students' thinking in regard to the unit ENV2022. This table represents the percentage of students from the unit ENV2022, who mentioned one of the open-coded themes listed below within their open-ended response to the question *"In the unit ENV2022, did your activities at the JMR change your thinking about Environmental Monitoring and Sampling?"* (n=13)

Open-coded Theme	Percentage of Respondents (No. of Students)
Improved Understanding of the Unit's Practical Applications	69.23% (9)
Reinforced Understanding of 'Environmental Monitoring and Sampling'	38.46% (5)
Learned Specific Survey and Sampling Techniques	38.46% (5)
Further Understood Complexity of Fieldwork and Research	15.38% (2)
Overall Views of 'Conservation Biology' Didn't Change	0% (0)

**Percentages have been rounded*