Integrating Ecology into the Environmental Engineering Curriculum – The Importance of Engagement

Structured Abstract

CONTEXT

Griffith University, Faculty of Environmental Sciences offered the first Bachelor in Environmental Engineering in Australia in 1991. This multidisciplinary program integrated science and engineering. The goal to produce graduate engineers who could solve environmental problems such as air and water pollution, contaminated land, solid waste by using their science knowledge and skills in engineering design. Ecology is a fundamental science and an understanding of ecological systems and processes is paramount to sustainably solving many environmental problems eg constructed wetland ecotechnologies. Thus it was essential that the Environmental Engineering curriculum incorporated ecology.

PURPOSE

The challenge was to integrate the discipline of ecology into the Environmental Engineering curriculum and in a way that would be relevant and engaging for the students. This required discussions with ecological staff and engineering partitioners. Fortunately I was appointed to that role having worked for 6 years in professional practice with a firm of consulting engineers.

DESIGN/APPROACH

Learning from Nature and the relevance of ecological concepts and principles to engineering students must be made apparent from first year through to fourth year. It was recognised that there should be a core course in Environmental Microbiology to provide the fundamentals of ecological processes that could then be applied to courses in wastewater, remediation of contaminated soils, wetlands for water pollution control. The challenge was to make this core course relevant and engaging.

OUTCOMES/RESULTS

The application of ecological processes to real world applications combined with weekly practical laboratories including a field trip really engaged the students. By integrating my own experiences in professional practice, I was able to effectively engage the students by demonstrating the importance of ecological concepts to engineering applications and management.

CONCLUSIONS

An understanding of ecological processes is essential to an environmental engineer, however in order to get students to appreciate the value of ecology, the application to real world examples must be demonstrated. This can be achieved by sharing research and industry experiences and by designing practical labs and field trips that engage students.

KEYWORDS

Ecology, Ecological Engineering, Environmental Engineering, Engagement

Integrating Ecology into the Environmental Engineering Curriculum – The Importance of Engagement

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BACKGROUND

Environmental Engineering v Ecological Engineering

Environmental Engineering was created as a discipline of engineering in the 1970's to focus on waste water solutions to primarily protect human health (sanitary engineering). The US Clean Water Act 1972 revolutionised the treatment of wastewater 'to better manage waste, protect human health and value environmental quality (Jorgensen and Mitsch, 2000; Gattie et al., 2003). Greater awareness of environmental degradation has prompted concerns over the future sustainability of the natural environment. Thus, today the focus is not only on protecting environmental quality but also on long term survival of natural ecosystems.
Environmental Engineering now covers a wide range of topics around air, land and water including: wastewater and stormwater management; solid waste management and cleaner production; site remediation and rehabilitation; and ecosystem restoration. The creation and restoration of ecosystems that have been substantially disturbed by human activities such as water pollution and land degradation is referred to as Ecological Engineering.
Ecological Engineering was a term coined in the 1960's by Professor H.T.Odum in the USA and concurrently in China (commonly known as agro-ecological engineering) (Mitsch and Jorgensen, 2003)."We now define ecological engineering as '*the design of sustainable ecosystems that integrate human society with its natural environment for the benefit of both*" (p 365 Mitsch and Jorgensen, 2003).
Professors Bill Mitsch and Sven Jorgensen have pioneered and championed the concept and its applications (Jorgensen and Mitsch 2000; Mitsch and Jorgensen, 1989, 2003, 2004). The focus on ecological engineering, ecotechnologies and ecosystem restoration led to the establishment of the International Ecological Engineering Society in 1993 and the American Ecological Engineering Society in 2001.

Integrating Ecology

Matlock et al. 2001 describe Ecological Engineering as using "science based quantification of ecological processes to develop and apply engineering design based criteria for sustainable systems". Bergen et al. 2001 describe Ecological Engineering as 'the nexus of ecology and engineering design'; whereas Gattie et al. 2003, describe it as 'a new engineering discipline with a science base in ecology'.
In essence the discipline of Ecological Engineering requires input from both applied ecologists and traditional engineers with ecological training. Whilst Griffith University does not offer a degree in Ecological Engineering, components of the Environmental Engineering program do focus on ecotechnologies and ecosystem restoration. Thus, we produce graduates with some ecological training.

PURPOSE

Environmental Engineering at Griffith University

Griffith University, Faculty of Environmental Sciences offered the first Bachelor in Environmental Engineering in Australia in 1991. This multidisciplinary program would integrate science and engineering. The goal to produce graduate engineers who could solve environmental problems such as air and water pollution, contaminated land, solid waste by using their science knowledge and skills in engineering design. The inaugural but late professor Phillip Jones had to foresight to employ both engineers (chemical, civil) and scientists (hydrology, soil science, ecology) who had worked with engineers.

Several universities in Australia followed by offering new Environmental Engineering Programs however these were founded within existing Engineering Faculties offering either Chemical of Civil Engineering – 'science' therefore being outsourced to other Faculties/Departments.

Ecology is a fundamental science and an understanding of ecological systems and processes is paramount to sustainably solving many environmental problems eg wastewater treatment, constructed wetland ecotechnologies, phytoremediation, thus it was essential that the Environmental Engineering curriculum incorporated ecology.

The challenge was to integrate the discipline of ecology into the Environmental Engineering curriculum and in a way that would be relevant and engaging for the students. This required discussions with ecological staff and engineering partitioners. Fortunately I was appointed to that role having worked for 7 years in professional practice with a firm of consulting engineers as their senior environmental scientist. As an 'applied ecologist' I had worked on numerous ecological engineering projects and environmental assessments/audits.

DESIGN

Approach

Learning from Nature and the relevance of ecological concepts and principles to engineering students must be made apparent from first year through to fourth year. It was recognised that there should be a core course in Environmental Microbiology to provide the fundamentals of ecological processes that could then be applied to courses in wastewater, remediation of contaminated soils, wetlands for water pollution control. The challenge was to make this core course relevant and engaging.

Implementation

My role as an ecologist by tertiary training, my previous 'vocational' teaching experience in natural resource management (Northern Rivers College of Advanced Education), my seven years of professional practice as an environmental consultant working with engineers would provide me with the tools I needed to successfully integrate ecology into engineering at Griffith University.

Over the years I have developed 4 courses: 2 core - *Environmental Microbiology and Ecology*; *Ecological Concepts and Applications*; and 2 electives *Wetland Systems in Environmental Management* and *Site Remediation and Rehabilitation.* The emphasis of my courses has been the application of ecological concepts and principles to environmental management and ecotechnologies, drawing upon examples from my own industry experiences (consultancies) and my applied research in wetland systems for water pollution control and bioremediation.

In this paper I will focus on one course *Environmental Microbiology and Ecology.* I will outline the chronology of the course development and implementation; I will demonstrate how I integrate ecology and microbiology into the course to make it interesting and engaging for the students.

RESULTS

Chronology of Course Development of Environmental Microbiology and Ecology

- In 1991, this course was first delivered and offered to the environmental engineering students as 'Environmental Chemistry and Ecology', but it was recognised that there was substantial overlap between the existing Environmental Science courses "Environmental Chemistry" and "Foundation Ecology".
- Major redesign occurred, and in 1992, a new course, Environmental Microbiology and Ecology, was delivered. The 'Ecology' lecture components (40%) were shared lectures with Foundation Ecology, and taught by ecology staff in Environmental Science. The 'Environmental Microbiology' lecture component (60%) was taught by me. All the practical labs were designed and run by myself.

- Course evaluations revealed that the Engineering students were concerned about "*the lack of relevance of the ecology component being taught by the Environmental Science ecology lecturers"*. This reinforced the importance of my own professional engineering experience as an applied ecologist in being able to make ecology interesting and relevant to the Engineering students simply by relating the content (principles and concepts) to real-world applications.
- Major restructuring for both Environmental Science and Environmental Engineering programs and courses took place in 1998 and the common ecology component taught by Environmental Science lecturers was removed. I had sole convenorship and teaching responsibility for Environmental Microbiology and Ecology. Course evaluations were extremely positive.
- Environmental Microbiology and Ecology has continued as a core course for Environmental Engineering. It has now become a core for students in Environmental Science majoring in Water Pollution Management, and Science students majoring in Microbiology, and an elective for students in Environmental Management and Science. Course evaluations continue to be very high.

This chronology emphasises the importance of designing and delivering 'ecology' by an applied ecologist who has worked with engineers (or an ecological engineer or an engineer with some ecological training). Courses in 'ecology' which are 'outsourced' to other non-engineering Departments may not meet the real needs of environmental engineers. It is interesting to note at Griffith University that students from non-engineering Departments are now enrolling in Environmental Microbiology and Ecology. In 2014 these students made up 60% of the enrolments.

Course Structure of Environmental Microbiology and Ecology

Environmental microbiology (and ecology) is a new discipline to all engineering students. While some students studied biology at school, the focus of the high school curriculum is at the macro level. We therefore have to deliver the course assuming "no prior knowledge". We have to start with basic principles and concepts of cells and cellular processes before we can discuss the applications of microbial processes. However, to stimulate the students, the first week of lectures makes use of videos showing the ecological and industrial importance of micro-organisms in a global setting, followed by interactive discussions in the tutorial.

Linking basic concepts and principles to tangible problems and solutions is paramount to student engagement and learning. Understanding the biochemical processes of cell metabolism - photosynthesis, respiration, fermentation, can be very daunting to students without a chemistry and/or biology background. However, they are vital for understanding ecosystem functioning. By linking basic concepts such as no light → no photosynthesis → no oxygen → no animals; the message gets across.

- Example 1: Excessive silt runoff from a construction site enters the local waterway → increases water turbidity → reduces light availability → reduces photosynthesis → reduces oxygen availability → fish die. **Solution:** Sediment and erosion control must be enforced and stormwater treatment devices designed (ponds and wetlands) to protect downstream aquatic ecosystems.

- Example 2: Excessive silt and nutrients from agricultural runoff enters the shallow coastal waters → increases water turbidity → reduces light availability → reduces photosynthesis → loss of seagrass → loss of food for dugongs and green turtles. **Solution:** Sediment control and riparian buffer zones must be enforced to protect downstream coastal ecosystems and the Great Barrier Reef.

- Example 3: Sewage enters our rivers, increasing nutrients and BOD. Nutrients increase algal growth → increases algal blooms → production of toxic by-products by cyanobacteria. Organic material (BOD) is a food source for non-photosynthetic micro-organisms. Micro-organisms increase → oxygen consumption increases → reduces oxygen availability → fish die. **Solution:** Sewage must therefore be treated by micro-organisms at the sewage treatment plant to remove nutrients and organic matter load. Next Concept: We then need to know the requirements of these micro-organisms to optimise metabolic efficiency - again linkages are made.

Lecture Component*:* This course has 2 lectures and 1 tutorial per week. Table 1 presents the course content starting with basic microbial and ecological concepts followed by the environmental and ecological engineering applications. Table 2 indicates the relevance of the course content to environmental problems/issues.

Table 1 Chronological course content in Environmental Microbiology and Ecology

Overview of environmental microbiology; Classification of micro-organisms: Cell structure and function; Microbial growth and control; Microbial biodiversity: Eukaryotes; Prokaryotes and viruses; Microbial metabolism- photosynthesis, chemosynthesis; aerobic and anaerobic respiration, fermentation; Aero microbiology; Soil microbiology and bioremediation; Ecological processes – energy flow-food webs; Role of micro-organisms in biogeochemical cycling; Microbiology of drinking water and wastewater treatment; Aquatic microbiology and ecology; Wetlands for water pollution control; Macroinvertebrates as bioindicators of aquatic ecosystem health. Microbial interactions with other organisms (plants, animals and fungi); Bioremediation and phytoremediation; Industrial applications; Microbial mining.

Table 2 Environmental Problems and Course Content in Environmental Microbiology and Ecology

Environmental Problems /Issues	Relevant Course Content
Water Pollution Aquatic Ecosystem Health Eutrophication Public Health Sewage Treatment	Microbial biodiversity Use of microscope; examination of pond water; cyanobacteria, filamentous algae, sewage sludge Examination and enumeration of activated sludge floccs Culture of bacteria from water samples Microbial metabolism: photosynthesis, chemosynthesis, aerobic and anaerobic respiration, fermentation Ecological processes – energy flow & biogeochemical cycles Acid sulphate soil formation Microbiology of drinking water and wastewater treatment; Aquatic microbiology and ecology; Macroinvertebrates as bioindicators of aquatic ecosystem health Water quality monitoring Wetlands for water pollution control Macrophytes types/species for constructed wetlands Phytoremediation Microbial interactions with other organisms Bioremediation of marine oil spills Industrial applications of microorganisms
Contaminated soil Land degradation Solid waste management	Soil microbiology and bioremediation Culture of bacteria from soil samples Microbial metabolism: photosynthesis, chemosynthesis, aerobic and anaerobic respiration, fermentation Acid sulphate soil formation Bioremediation of contaminants & xenobiotics Phytoremediation Phytocaps Microbial interactions with other organisms Industrial applications of microorganisms
Air pollution	Aero microbiology Air borne pathogens Culture of bacteria from soil samples Acid rains Bioindicators of air pollution

Practical Component: A major learning component of Environmental Microbiology and Ecology are the weekly 3 hour laboratory **practical exercises** (Table 3). They are important learning tools designed to complement or supplement the lecture material; engage students and provide competency skills. A **practical manual** has been prepared for the students and they must keep their own notebook. The manual and notebook have been successful in improving learning outcomes in three ways: (1) encourages students to keep good practical records in their notebooks; (2) encourages students to carefully follow instructions in their Practical Manual; (3) assesses students' "hands-on" practical skills and competency to carefully observe and accurately record.

A Practical Exam forms a major assessment item however the students can refer to both the practical manual and their own note book. A revision week with staff assistance is provided prior to the practical exam. Students can go through techniques and examine samples. The practical exam is a non-threatening situation and provides an accurate record of a student's competence.

Table 3 Laboratory Content in Environmental Microbiology and Ecology

Laboratory Content	**Relevance to Environmental and Ecological Engineering**
Microbial biodiversity- use of microscope; examination of pond water; sewage sludge	Water Pollution; Components of Ecosystems
Culture and Enumeration of bacteria from soil and water samples	Water Pollution; Public Health Sewage Treatment, Contaminated Soil
Osmosis and Diffusion	Water Pollution; Contaminant Transport
Examination of Activated Sludge – filamentous bacteria, floccing, protozoan & metazoan fauna.	Water Pollution; Sewage Treatment
Diversity of Microorganisms: Protozoa, Algae, Fungi	Components of Ecosystems; Bioremediation
Diversity of Animal Kingdom with emphasis on aquatic macroinvertebrates as bioindicators	Components of Ecosystems, Water Pollution; Aquatic Ecosystem Health,
Diversity of the Plant Kingdom with emphasis on wetland plants	Components of Ecosystems ,Water Pollution, Rehabilitation, Wetlands
Pond Ecology- water quality monitoring, sampling macroinvertebrates & wetland plants	Water Pollution, Aquatic Ecosystem Health, Eutrophication, Wetlands

Course Evaluation*:* Both formal and informal Course Evaluations are routinely conducted. The Student Evaluations of Course (SEC) are administered centrally. Environmental Microbiology and Ecology has consistently been ranked in the top 85-96% with scores of 4.6-4.8 out of 5 for 'Engagement in Learning' and 'Overall Satisfaction'. An example of the 2014 SEC is given in the Appendix.

Students can provide qualitative responses to the open question "*What did you find particularly good about this course?"* A review of these answers show that besides being an inspirational and enthusiastic lecturer, the practical/laboratory component and the relevance of the lecture component to 'real world problems and solutions' are central to engaging student learning and the importance of ecology in the engineering curriculum. A selection of 10 student responses relating to the practical component and the lecture component over the last 5 years is given in Table 4.

A Course Experience Questionnaire to final-year students, showed that students strongly agreed that Environmental Microbiology and Ecology "provided good background knowledge for material in later years"; "as a core course it was appropriate for an environmental engineering degree". The course was also ranked very highly in terms of it being "interesting", "practical", "educational" and "useful for career". This feedback is positive, and highlights my effectiveness in integrating ecology into the Environmental Engineering program.

Table 4 Student Responses to Environmental Microbiology and Ecology

What did you find particularly good about this course? 2010-2014
Comments relating to the practical component:
The best thing about this course was the labs that took place each week.
The labs as these emphasised our learning's from that week's lecture and helped gain a better understanding with visible proof/examples.
The practicals really helped to cement my knowledge of what we covered in class
I really enjoyed the practical component of the course, especially the field trip to the pond on-campus
Practicals were hands-on, useful and interesting
Laboratories where engaging and informative, highly recommend it for anyone interested in the environment or microbiology.
Practical applications in the labs helped instil the material
It was helpful that the labs related to the content learnt.
The labs were engaging in learning the material.
Practical components were good and refreshing and complemented the theory work
Comments relating to the lecture component:
The applications in real life, made me appreciate the importance of microorganisms
The relevance of microbiology and ecology to solving environmental problems
This course was extremely relevant to engineering (environmental) and it was very engaging and practical.
Constructed wetlands and their application to treating sewage and stormwater
Material was interesting and presented in an organised and in a way that made it easy to see the real world applications
Very interactive. The lecturer ties the content to real world examples of how we cannot function without bacteria and microorganisms in general.
I'm currently doing the Water and Wastewater course, the microbiology course was very helpful for me. It is a good combination between these two courses.
At the start of the semester I hated this course because it was all new, and as an engineer I had never done biology before. Now it has become my favourite course because I've learnt so much about biological and ecological systems and their relevance to solving environmental problems
I feel as though I have learnt more in this course than any other so far. It was good because it started off with basics, as most of the class had no prior knowledge of the content, and then built on that showing the applications to real life.
The importance of microorganisms to engineering ecotechnology – wetlands, sewage treatment, bioremediation to solve environmental problems.

DISCUSSION

The practicals were a key component for learning and student engagement in microbiology and ecology. As identified in the student evaluations (Table 4) and reported by Feisel and Rosa (2005) ; Maldarelli et al. (2009) : ' the laboratory provides one of the best opportunities for active learning as laboratory classes are designed to teach though experiential teaching' p51. Whilst video laboratory demonstrations appear to be replacing face-face hands on laboratory classes due to cost-cutting, on-line delivery and advances in multimedia (Gilbert et al., Jackson et al., Maldarelli et al. 2009); laboratory classes with demonstrators are still run for Environmental Microbiology and Ecology at Griffith University; and interestingly enrolments are increasing beyond environmental engineering students to science students wanting this 'hands on' 'face to face' practical skills experience.

OUTCOMES/ CONCLUSIONS

An understanding of microbial and ecological processes is essential to an environmental engineer, however in order to get students to appreciate the value of ecology and microbiology, the application to real world examples must be demonstrated. The relevant lecture content combined with weekly practical laboratories including a field trip engaged the students. By integrating my own experiences in professional practice, and research I was able to effectively engage the students by demonstrating the importance of ecological concepts to engineering applications and management. This is paramount to motivating students, keeping them interested, and stimulating them so that they want to learn.

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Appendix 1 Student Evaluations of Course 2014

Student Experience of Course (SEC) - Detail Report

Produced on 16 Jun 2014, 2:31 pm by Margaret Greenway (s354370). Survey ID: 102771-3141-2-1

School:	Griffith School of Engineering	**Course:**	Env Microbiology & Ecology - 2202ENG	**Campus/MoD:**	NA / P
Group:	Griffith Sciences	**Semester:**	Semester 1 2014 (3141)	**Course size:**	49
Convenor(s):	Margaret Greenway			**Participation:**	49% (24 of 49)
Class(es):	LAB/B101, LAB/B102, LAB/B103, LAB/B104, LEC/L101, TUT/T101			**Size/part:**	49 / 49% (24)

Quantitative Summary:

	Question	#		Score	Quartile Band Comparison	%+ve %-ve	Median	Std dev	Mean	Comparative mean			Quartile Band Rank
										25%	50%	75%	
Q1	This course was well-organised.	**15** **7** **1** **0** **0**	SA A N D SD	65.2% 30.4% 4.3% 0% 0%	35.6% 42.5% 12.9% 6.1% 2.9%	+95.6 -0	5	0.58	**4.6**	3.7	4.1	4.4	4
Q2	The assessment was clear and fair.	**16** **5** **1** **0** **0**	SA A N D SD	72.7% 22.7% 4.5% 0% 0%	33.5% 41% 14.5% 7.7% 3.3%	+95.4 -0	5	0.57	**4.7**	3.6	4.0	4.3	4
Q3	I received helpful feedback on my assessment work.	**17** **4** **1** **0** **0**	SA A N D SD	77.3% 18.2% 4.5% 0% 0%	33.8% 34% 19.8% 8.2% 4.1%	+95.5 -0	5	0.55	**4.7**	3.5	3.9	4.3	4
Q4	This course engaged me in learning.	**15** **6** **1** **0** **0**	SA A N D SD	68.2% 27.3% 4.5% 0% 0%	37.2% 38.8% 15% 6% 3%	+95.5 -0	5	0.58	**4.6**	3.7	4.1	4.4	4
Q5	The teaching (lecturers, tutors, online etc) on this course was effective in helping me to learn.	**17** **4** **1** **0** **0**	SA A N D SD	77.3% 18.2% 4.5% 0% 0%	38.8% 37.4% 14.2% 5.8% 3.7%	+95.5 -0	5	0.55	**4.7**	3.7	4.1	4.4	4
Q6	Overall I am satisfied with the quality of this course.	**16** **5** **1** **0** **0**	SA A N D SD	72.7% 22.7% 4.5% 0% 0%	32.9% 42.3% 14.7% 6.5% 3.5%	+95.4 -0	5	0.57	**4.7**	3.6	4.0	4.3	4

Legend 5pt Likert scale: SD - Strongly Disagree, D - Disagree, N - Neutral, A - Agree, SA - Strongly Agree
QUARTILE BANDING SCORING: A score 1, 2, 3, or 4 will be assigned depending on which quartile band your mean score falls within. Quartile scores are based on aggregate data calculated from a matrix of Group x Course/Class Size. The comparison is made between courses within the SAME group and of the SAME size (<21, 21-50, 51-200, 200+). A score will only be assigned if more than three courses exist (from any semester) within the same category.
This is a custom question.

Student Experience of Course (SEC) - Detail Report

Produced on 16 Jun 2014, 2:31 pm by Margaret Greenway (s354370). Survey ID: 102771-3141-2-1

School:	Griffith School of Engineering	**Course:**	Env Microbiology & Ecology - 2202ENG	**Campus/MoD:**	NA / P
Group:	Griffith Sciences	**Semester:**	Semester 1 2014 (3141)	**Course size:**	49
Convenor(s):	Margaret Greenway			**Participation:**	49% (24 of 49)
Class(es):	LAB/B101, LAB/B102, LAB/B103, LAB/B104, LEC/L101, TUT/T101			**Size/part:**	49 / 49% (24)

Qualitative Responses:

Q7	**What did you find particularly good about this course?**	Resp#: 17 / Class
1	The lecture notes and lecture summaries available ahead of time online. The small size of lab classes was also very good.	LEC/L101, TUT/T101, LAB/B103
2	This course was extremely relevant to engineering (environmental) and it was very engaging and practical. Every aspect of the course was interesting and hands on and was run very well	LEC/L101, TUT/T101, LAB/B103
3	Very interesting and applied content. All lecturers and guest speakers are clearly passionate about the subject and this transfers on to students. Pracs were also hands-on, useful and interesting	LEC/L101, TUT/T101, LAB/B103
4	Very well organised. Interesting labs, interesting content. Enthusiastic lecturers (Peter Pollard)	LEC/L101, TUT/T101, LAB/B103
5	The lectures were passionate and enthusiastic in teaching us the content in this course as it aligned with their areas of expertise.	LEC/L101, TUT/T101, LAB/B103
6	Laboratory sessions were very good.	LEC/L101, TUT/T101, LAB/B103
7	Practical components were good and refreshing , rather than always doing theory work	LEC/L101, TUT/T101, LAB/B102
8	The practical assessments and field lectures	LEC/L101, TUT/T101, LAB/B102
9	I liked the layout and weighting of assessments and the tutes each week after the lecture. At the start of the semester i hated this course because it was all new, and as en engineer i had never done biology before. Now it has become my favourite course because i have learnt so much about biological and ecological systems. I feel as though i have learnt more in this course than any other so far. It was good because it started off with basics, as most of the class had no prior knowledge of the content, then built on that.	LEC/L101, TUT/T101, LAB/B102
10	Very interactive and Professor Pollard ties the content to real world examples of how we cannot function without bacteria and microorganisms in general.	LEC/L101, TUT/T101, LAB/B101
11	Peter was such a good lecturer. He had such a good attitude towards the topic, genuinely wanted us to enjoy it and made what could have been a boring lecture very interesting and engaging.	LEC/L101, TUT/T101, LAB/B101
12	Laboratories where engaging and informative, highly recommend it for anyone intreated in the environment or microbiology. Lecturing staff are amazingly talented as what they do	LEC/L101, TUT/T101, LAB/B101
13	Material was interesting and presented in an organised and in a way that made it easy to see the real world applications.	LEC/L101, TUT/T101, LAB/B104
14	All the material was put online at the beginning of the course The lecture notes were also in note form, not just powerpoints, which was really good.. The labs were engaging in learning the material.	LEC/L101, TUT/T101, LAB/B104
15	I liked the style of assessment and the percentage for each piece of assessment was appropriate to how much effort was required.	LEC/L101, TUT/T101, LAB/B104
16	I found the lectures useful and it was helpful that the labs related to the content learnt. The lab demonstrators were extremely helpful.	LEC/L101, TUT/T101, LAB/B104
17	lots of learning material. Practical applicatipons in the labs helped instill the material	LEC/L101, TUT/T101, LAB/B104

Q8	**How could this course be improved?**	Resp#: 9 / Class
1	I would have liked either online readings available or a textbook I could buy from the co-op, as I would have liked to do some further readings to help me understand some concepts I struggled with. Often I couldn't find what I was looking for in the library, and references to a text book I couldn't access wasn't very useful.	LEC/L101, TUT/T101, LAB/B103
2	no improvements are needed	LEC/L101, TUT/T101, LAB/B103

Legend 5pt Likert scale: SD - Strongly Disagree, D - Disagree, N - Neutral, A - Agree, SA - Strongly Agree
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This is a custom question.

3	I would have liked to see a dedicated textbook for the course - a couple of texts were recommended, however no type of microbiology text was available at the co-op bookshop and the textbooks available in the library were out of date. I think this is less a course recommendation than a recommendation for better uni resources to support the course.	LEC/L101, TUT/T101, LAB/B103
4	Make more use of the tutorials, perhaps by have questions on the previous week content.	LEC/L101, TUT/T101, LAB/B103
5	Lectures can be more interesting as some parts were found to be boring	LEC/L101, TUT/T101, LAB/B102
6	Nothing	LEC/L101, TUT/T101, LAB/B102
7	No need for improvement very happy with the course.	LEC/L101, TUT/T101, LAB/B101
8	Nothing.	LEC/L101, TUT/T101, LAB/B101
9	Using the tutorial sessions more effectively to benefit students more; such as giving revision questions to be completed before the tutorial and brought in to ensure content is understood and students keep up to date.	LEC/L101, TUT/T101, LAB/B104