Chapter 3: Physics delivering to Agriculture students

Background
The targeted unit of study, CROP1002, *Agricultural Science 1B*, is delivered to first year students in the Faculty of Agriculture and has been since 1995. Two-thirds of the unit of study is delivered by the School of Physics (one-third climatology, one-third agricultural environment and equipment) and one-third by the Faculty of Agriculture (world climate, zones, etc.).

Student learning and motivation in service units of study improves when the teaching of concepts is situated within the context of the students’ professional degree program. As a Faculty of Agriculture unit of study CROP1002 *Agricultural Science 1B* situates the learning of physics within agriculture and, prior to 2001, the School of Physics had already taken a contextual approach whereby the physics underpinned the agricultural science. The unit of study was also being delivered in a more flexible manner than the traditional lecture and laboratory format. Students attended:
- 2 one-hour lectures per week for 2/3 of the semester;
- 1 one-hour workshop per week for 2/3 of the semester;
- 3-hour laboratory for 4 weeks; and
- 2 field trips to Camden.

Most students taking CROP1002 *Agricultural Science 1B* were enrolled in the Bachelor of Science in Agriculture program. With the introduction of new degree programs, Bachelor of Horticultural Science, Bachelor of Land and Water Science and the proposed Bachelor of Animal Science, students enrolled in CROP1002 *Agricultural Science 1B*/HORT1002 *Horticultural Science 1B*/LWSC1002 *Land and Water Science 1B* were all required to study the same material. The unit of study did not contain enough relevant material for HORT1002 *Horticultural Science 1B*/LWSC1002 *Land and Water Science 1B*. Current education research tells us that the student learning experience is enhanced if the student engages with the material and so there was also seen to be a need to further increase the flexibility of delivery. So there was a need to review the learning materials offered.

Development proposal
The School of Physics proposed to:
- restructure the teaching and delivery of material to Agricultural Science students (target group) by modifying and/or rewriting some of the teaching materials used within CROP1002 *Agricultural Science 1B*/HORT1002 *Horticultural Science 1B*/LWSC1002 *Land and Water Science 1B* to make them more relevant/appropriate to the professional degree programs;
- move to more appropriate and more flexible delivery of some of the physics material within CROP1002 *Agricultural Science 1B*/HORT1002 *Horticultural Science 1B*/LWSC1002 *Land and Water Science 1B*;
- if possible, ensure that material produced could be used in a cross-section of degree programs; and
- ensure the model used could be transferred to other disciplines.
Summary of development

Two topics were chosen for web-based delivery – one topic from the Climatology section (The El Niño Effect and Southern Oscillation Index) and one topic from the Agricultural Environment and Equipment section (Transfer Processes). Lectures in which these topics would previously have been delivered were replaced by sessions in the computer laboratory with pairs of students working with the web pages.

The new mode of delivery for the above two topics was used for the first time in 2001. Evaluation of the changes to the unit included student evaluation (by use of survey, interviews and in-class activities), and teacher evaluations of the design and integration of the materials. The web modules were also reviewed by UniServe Science in terms of aspects such as presentation, navigation, consistency, and clarity.

In 2002, three additional topics were chosen for web-delivery: circulation systems; fluids; and waves. These new modules were first delivered in Semester 2, 2002. In addition, a comprehensive student course book was produced, assessment was reviewed and restructured to make it more transparent to students, and “Mindmaps” were introduced as student activities to assist students in the processing of information and the construction of links between concepts. Evaluation of these changes included student evaluation (by use of survey, and observation), and staff evaluations.

An objective of the project was to have the web-based modules accessible via WebCT in Semester 2, 2002. However, as the materials and delivery of the unit of study were still undergoing evaluation and significant modification during this time it was seen to be more appropriate to delay the WebCT interface until 2003. For 2002, student access to the web-based modules was from a home page set up by the Physics unit coordinators specifically for the Agriculture students.

Other physics units of study have been identified where the modules may be used, either for revision, just-in-time learning, or core topics. For example, in Semester 1, 2002, the module on waves was used in PHYS1002 Physics 1 (Fundamentals) and the module on fluids was used in PHYS1003 Physics 1 (Technological).

Detail of development and evaluation

Timeline

<table>
<thead>
<tr>
<th>Semester</th>
<th>Activity</th>
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<tbody>
<tr>
<td>Semester 1, 2001</td>
<td>Identify topics that lend themselves to online delivery</td>
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<td>Develop and implement topics</td>
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<tr>
<td>Semester 2, 2001</td>
<td>Trial with CROP1002/HORT1002/LWSC1002</td>
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<td>Evaluate participant reaction, students and staff</td>
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<td></td>
<td>Modify online modules, if necessary</td>
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<td>Semester 1, 2002</td>
<td>Develop and implement additional online modules</td>
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<td>Combine existing printed material into a comprehensive coursebook</td>
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<td>Write additional material for coursebook where necessary</td>
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<td>Semester 2, 2002</td>
<td>Complete phasing in of Mindmaps</td>
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<td>All modules to be online, accessible via WebCT</td>
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<td>In-depth evaluation</td>
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<td>Identify and document other teaching programs where the modules might be used, either for revision, just-in-time learning, or core topics</td>
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Unit of study – learning resources
Identifying topics that would be better delivered via the Web and preparing the necessary web-based material has required an extensive review of all material delivered. This has resulted in improved contextualisation of the physics thus making it more meaningful for the Agricultural Science students.

Lectures: Of the original 18 lectures given at the rate of two per week for nine weeks, 14 lectures were retained as face-to-face and four lectures were replaced by web-based activities which the students do at a time suitable to them.

Workshops: The aim of the workshops is to support the learning of new concepts and skills through group interaction. At the beginning of semester students are assigned to a group of four students. Of the original nine workshops, eight were retained as classroom activities and one was replaced by a web-based activity. Mindmapping is used by students in all the workshops (see notes below for details).

Web-based modules: Five web-based modules have been produced for the Agriculture students during the project:
- Circulation systems
- El Niño and Southern Oscillation Index
- Transfer Processes
- Life in a Fluid
- Waves

Information in the web-based modules is given in small chunks, interspersed with pictures and diagrams. Students are encouraged to visualize concepts and ideas and place them in real world contexts. The students are guided through topics in a stimulating, non-threatening way. For example, the module on fluids draws students in with ‘Have you marveled at the wonders of the sea, the dynamics of hurricanes and tornados, the thrill of white water rafting! Been amazed at how aircraft can fly and birds soar!’ It then takes the student through the complex behaviour of fluids, starting with simple models and progressing to the more difficult concepts. The web pages contain lots of examples in a variety of contexts that the students can relate to. Often a question is posed for consideration by the students, e.g. ‘Why does a ball curve in flight?’ followed by a tutorial style presentation of the underlying physics.

Mindmaps: One of the major aims of the unit of study is for students to be able to use a wide range of scientific terminology correctly, be able to interpret information and make judgments based on sound scientific arguments. Mindmaps were introduced as a student activity to assist them in making appropriate connections between the various concepts. In the workshops students work in small groups to produce Mindmaps, whereas for the web-based exercises the students produce individual Mindmaps. Students use A3 paper for their Mindmaps and are encouraged to use illustrations and colour. The Mindmaps appear to assist students with the processing of information and the construction of links between concepts. When involved in the group exercises the students spend most of the time on task and engage in constructive dialogue.

The Mindmaps have also proved to be a useful way to assess students. Using the mindmaps for assessment has been useful for staff because they are relatively quick for grading since the grading was done on a scale of satisfactory, adequate, unsatisfactory.
by perusing the links. From the students’ point of view, they get feedback at weekly intervals and in some cases twice a week, whereas without the mindmaps there would only be two assignments, maybe three, during the nine weeks. All Mindmaps – group ones from the workshops and individual ones from the web-based activities – are submitted by students as part of their continual assessment. The format of the Mindmap allows for quick marking, thus making it feasible as a realistic assessment tool for marking assignments for large numbers of students without placing too great a burden on limited staff time.

**Coursebook:** Prior to this project, students received a number of different sets of notes for the various components of the unit of study. During the reviewing and restructuring of the unit of study a comprehensive student coursebook has been produced. It includes information on/for: lecture content; interactive group workshops; laboratory experiments; Camden field trips; and web-based activities. The coursebook brings together notes on basic physical principles and topics relevant to future agricultural scientists. In addition, the coursebook presents the physics component (two-thirds) of the unit of study to the students as a cohesive set of modules. The coursebook has been extremely well received by students and has greatly assisted staff in the delivery of the unit.

**Assessment:** Assessment is a driving force for students and is a crucial element in any unit of study. During the restructuring of the unit of study student assessment was reviewed and revised to make the process more transparent to the students. All components are now assessed with approximately 50% contribution from continuous assessment and approximately 50% from the end of semester examination. Continuous assessment is taken from the workshops, laboratories and field trips.

**Laboratories:** Of the original four laboratories given one in each of weeks 3, 4, 5, and 8, three have remained as they were in the past, whilst the one on web research has been rewritten to focus on interpretation using physical phenomena.

**Field trips:** The unit has two field trips during which the students carry out experimental work at the Camden field station. The experiments are on solar energy and soil conditions. The activities range from taking measurements using a solar panel to using water equipment. The field activities are aligned with the rest of the components. Unfortunately, in 2001 there was a problem with the timetabling of the field trips. This was resolved in 2002 and is reflected in the improved student response in the 2002 evaluation.

**Revision of the unit of study**
Information obtained through the evaluation process was used to:
- guide modification of and enhancement to the teaching materials;
- guide changes aimed at improving the student learning experiences within the targeted first year unit of study; and
- assist in evaluation of the underlying model for teaching reform.
Evaluations
There were five relevant evaluations done during the review and restructuring of this unit of study:
- the first was conducted during Semester 2, 2001 and was an evaluation of student perceptions of the purpose and usefulness of the resources in the physics two-thirds of the unit;
- the second was also conducted during Semester 2, 2001 and was an evaluation of the online module called Transfer Processes;
- the third was conducted at the end of Semester 2, 2002 and was an evaluation of student reactions to and perceptions of the modifications implemented in 2002;
- the fourth was a measure of the perception of the teaching staff with respect to their involvement in the planning and implementation of the teaching innovation; and
- the fifth was an evaluation of the new coursebook and delivery structure by tutors.

1. Student perceptions of the purpose and usefulness of the resources
The physics components of the Agricultural Science unit of study were evaluated in 2001 using a student survey and student interviews. The interviews were used to see how the students reacted to the presentation of the web-based modules. The paper-based survey sought general demographic data and asked questions about students’ perceptions of the physics components of the unit of study, their comfort level with regard to specific aspects of IT, what their preferences were for working together or alone, what resources they had used in supporting them in their learning, what they perceived to be the purpose of the web-based modules, workshops, laboratory classes, Camden field trips, and the relevance of the unit of study to their professional degree program. The survey instrument is presented in Appendix 1A and the full analysis of the survey is in Appendix 1B. A summary of the analysis is presented here.

- **Demographics**
The students come from three different Agriculture degree programs, but share a common first year of study. Of the 78 students taking the unit 64% responded to the paper-based survey of which 53% were female (47% male), all were full-time students, and 86% are either direct school leavers or at least not long out of school, 96% were used to using the Internet with 94% using email.

- **Information technology skills**
Asked for their comfort level with a number of Information Technology skills, 84% responded that they were comfortable or very comfortable with database use, and 92% that they were comfortable or very comfortable with the use of word processing. The only computer-based skill that the students were uncomfortable with was the use of online discussion groups, where 48% reported discomfort.

- **Peer-peer interaction**
Peer group interaction is built into the unit of study structure. Students are put into groups of four for laboratory work, workshops and field trips. When studying, 84% of the respondents give a preference for studying collaboratively, although 55% of students report they have not done so. Informal collegial help with study is common, with around 80% discussing some aspects of the unit with others and exchanging lecture notes and helping other students.
• **Extent of collaborative learning**
Pearson’s correlation (see full evaluation report in Appendix 1B) was used to investigate links between gender, age, and collaborative study. Males are more likely than females to have helped another student catch up. They are also more likely than females to have met with other students to study, met regularly with another Agriculture student to study, and to have organised an Agriculture study group.

There are many intercorrelations between virtually all of the ‘helping others with study’ factors such as meeting with other students to study, sharing notes, discussing Agriculture with others and organising a study group. Most of the helping behaviors are common, with sharing lecture notes, discussing Agriculture with peers and helping another catch up being the most common (70-83%). Less common, at 45% was meeting with another student for study. Even less common was meeting with another student regularly for study (22%).

• **Resources used for study**
There is a small majority of students who prefer to study using both web-based materials and text-based materials (55%). A large minority (41%) of students are happy with studying from just the book of course notes and lecture notes (and presumably the laboratory notes), but despite this, 96% had tried two of the web sites and 94% tried the third web site. This web site usage may well have been in the workshops, where two of the sites formed part of an exercise. Of the students who tried the web sites, the approval rating was high with an average of 83% finding them either useful or extremely useful. There is no significant correlation between preference for studying from web-based materials versus print with gender, age, helping behaviours and collaborative study.

• **Use of resources for learning**
When this first survey was conducted there were two separate books of course notes for the unit of study – *Physical Principles & Processes in Agriculture* and *Climatology*. The two book resources gained a favourable rating from students, however 23% had not used the library and a further 23% did not find the library a useful support to their learning. This is not surprising, as using library resources is not a goal of this unit. The emphasis has been on the Web as a resource, largely because of the extensive availability of weather and climate data on the Web and secondly, as professionals, these students may have easier access to web data than library facilities. In addition 90% of the students found the practical notes to be useful/very useful.

The Camden field trips were found not useful by 35% of students and a small percentage (4%) did not attend them. However, 61% of students found the Camden field trips useful/very useful. It may be relevant to note that the timing of the field trips was not at optimum times for student attendance.

• **Components of the unit of study**
The purpose and reason for including the web-based modules was seen by the students to be: to provide a variety of learning and teaching methods or materials (43%); to provide opportunities and skills in using the Web for research and information gathering (29%); and to help in learning the material (23%). The students felt that the web-based material was more visual, more interesting and a self-paced style of research, which was
different from the normal lecture-based material. 80% of respondents felt that the web-based modules were very relevant.

Response to the workshops was overwhelmingly positive. The purpose and reason for inclusion of the workshops was seen by students to be: to provide opportunity for discussion, cooperation or interaction among peers (30%); to help in understanding or comprehension of the concepts (20%); to complement lectures, give examples of things in lectures or develop ideas presented in lectures (17%); to encourage independent study (8%); to provide a variety of learning methods (8%); and to see practical relevance of the material (8%). The students indicated they were learning without being formally ‘taught’ by the lecturers and they enjoyed that experience. Three of the 35 students who responded felt that the workshops gave them valuable practice answering questions.

The perceived purpose for practical work was: to experience real-world or practical application of theory (46%); to help with the understanding of the physical concepts (26%); to have some ‘hands-on’ experience (16%); to assist teamwork or social interaction (7%); and to provide another way of learning or a variety of learning experiences (5%). However, 24% of students questioned the relevance of the field trips.

Asked how worthwhile the unit had been to them, 46% of students found it worthwhile or relevant, while an additional 31% found it fairly worthwhile and 14% felt it was not relevant. When asked what else they would like to see in the unit of study, 31% of students suggested: changes to the practical work; more help and explanation required; more time needed to cover the content; content is too detailed and specific; and the physics needs to be more related to Agriculture.

With respect to the amount of each component in the unit of study, 58% of students were very happy with the current balance of the unit and some indicated that the variety of components made the unit interesting and enjoyable. Changes were suggested by 42% of students: decrease the lecture program or improve explanations (23%); increase web-based materials (13%), workshops (13%), field work (10%); and decrease workshops (13%), field work (10%), and practical work or make it more relevant (10%).

**Summary**

The feedback obtained through this evaluation was used by the unit coordinators to make appropriate changes to the learning materials and delivery of the unit of study for 2002. The Camden activities were better timed within the unit for 2002.

2. **Online module - Transfer Processes**

The online module for Transfer Processes was evaluated using an in-class activity during second semester, 2001 with the then enrolled CROP1002 Agricultural Science 1B/HORT1002 Horticultural Science 1B/LWSC1002 Land and Water Science 1B students. Students were asked to look at the online module, summarise the material covered and then answer questions relating to content, navigation, ease of use, and value to their learning. The questions and the analysis are in Appendix 2.

The students were very positive about the web site and the vast majority found the content easy to understand, the layout convenient, and the web site easy to use (86-91%). The most helpful learning aids were seen to be examples and diagrams (63%) and the clear explanations (20%). The feedback obtained through this evaluation was
used by the unit coordinator to improve the delivery and means of assessment for this module for 2002.

3. Further evaluation conducted at the end of Semester 2, 2002

As there were several changes to the structure and delivery of the unit between 2001 and 2002 it was appropriate to investigate the students’ responses to these changes. The survey was conducted at the end of Semester 2, 2002. The survey instrument is presented in Appendix 3A and the full analysis of the survey is in Appendix 3B. A summary of the analysis is presented here.

Of the 86 students who responded to the survey, 61 (71%) were enrolled in CROP1002, 6 (7%) in HORT1002, 13 (15%) in LWSC1002, 2 in Animal Science, and 2 in other programs. Surprisingly, only 35% came from a farming background. Also surprising, was that 29% of the students had not been in fulltime study in 2001, i.e. they had traveled or worked. Students enrolled in the unit had studied the following subjects for their HSC: Mathematics 2U or equivalent (48%); Mathematics 3/4U or equivalent (29%); Mathematics in Society or equivalent (14%); Physics (32%); Chemistry (63%); Biology (45%); Agriculture (30%); Science, other (6%); and no NSW HSC (2%).

There were 20 statements about the unit of study. Students were given a Likert five-point scale (5 = strongly agree, 4 = agree, 3 = uncertain, 2 = disagree, 1 = strongly disagree) to indicate their agreement to the statements. The statements can be divided into two sections – section 1 covering issues associated with the delivery of the unit of study, and section 2 covering resources. A synopsis of the Likert means is given below:

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<th>Section</th>
<th>No. of statements in section</th>
<th>Likert mean score</th>
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</thead>
<tbody>
<tr>
<td>Delivery</td>
<td>10</td>
<td>3.4</td>
</tr>
<tr>
<td>Resources</td>
<td>10</td>
<td>3.5</td>
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Students felt that the balance of lectures, workshops, web activities and experimental work was good and that having the variety of delivery modes helped them to remain engaged in the learning. Having done the unit they feel they now have a better appreciation for the importance and application of physical principles and processes in their professional pathway.

Students appear to have found the resources useful in helping them understand the content. It is pleasing to note here that the resources which rated the highest were those where most of the modifications had been carried out, i.e. the coursebook, the workshops, the Mindmaps, and the web-based modules.

4. Interviews with Physics and Agriculture staff

The staff closely associated with the physics components of the targeted agriculture first year unit and the follow-on second year agriculture unit were interviewed to ask them about their involvement in the development process and how well they perceived it was carried out. The questions used for this purpose are in Appendix 4.

The interviews indicated that communication has been very good within the project group, between the project and UniServe Science, and between the project and the School of Physics SUPER group. The SUPER group has been used as a reference group, especially in the development of a philosophy of what to put on the Web. A lot of time was spent in discussing the issues about what is a good web experience from the
student point of view and thus what should be put on the Web and what is better dealt with in lectures or workshops or laboratories. The project has enhanced the physics components of the unit of study but has not changed the agricultural component or the interface between the two.

5. Evaluation of the new coursebook and delivery structure by tutors

During Semester 2, 2002, tutors involved in the interactive workshops, laboratory classes and Camden field trips annotated their copies of the coursebook as they worked through each class activity. At the end of semester these data will be used to improve the notes and other aspects relating to the unit of study.

Summary of Teaching Improvement

The model took the approach of ‘value adding’ to an existing unit of study. The physics-delivered part of the unit of study was reviewed and restructured to make sure the various components were well integrated and relevant for students enrolled in CROP1002 Agricultural Science 1B, HORT1002 Horticultural Science 1B and LWSC1002 Land and Water Science 1B. Where necessary components were modified to improve delivery and/or make the material more relevant to the target group’s professional pathway. Topics within the physics sections of the unit were identified for web-based delivery and discrete modules created. In addition, to assist with cohesion, all previously paper-based material was collected together and added to organizing information to produce a coursebook.

The starting point was to consider the requirements of the Faculty of Agriculture and the nature of the students. The physics coordinators for the degree program wanted to give the Agriculture students an educational experience that was both motivating and relevant and that would allow them to become knowledgeable about physical principles and processes and for them to be able to apply these principles and processes to a wide variety of phenomena. The module aims/goals were clarified and the assessment of the unit of study was revised.

The next stage involved discussion about the content covered and what content would be most suited to web delivery. Many meetings were held to discuss the format of the web modules and what was intended to be achieved with them. Although the web-based modules are not interactive, strategically placed questions encourage students to think about key issues and the use of the assessable mindmaps strongly encourages students to process web-based information.

All paper-based material was combined into one comprehensive coursebook.

The final step in the restructuring was the timetabling of the unit of study so that lectures, interactive workshops, laboratories and web-based activities were correctly sequenced and that they complemented each other. One feature of the restructuring was that key concepts were revisited a number of times so that students gain a deeper understanding of these crucial ideas and concepts.

During the semester, feedback from UniServe Science, students and tutors enabled the unit coordinators to amend the web modules when necessary.

The restructuring has produced a unit of study that better serves the needs of the target group (students enrolled in CROP1002 Agricultural Science 1B, HORT1002 Horticultural Science 1B and LWSC1002 Land and Water Science 1B).
Horticultural Science 1B and LWSC1002 Land and Water Science 1B) and that encourages greater student participation by individuals and by groups.

One of the goals of the project was for some of the resources developed to be portable. The web-based modules have the potential to be transferred to other units of study for just-in-time learning, revision, or core topics. To some extent this has already been achieved very successfully. Some of the topics in CROP1002 Agricultural Science 1B are common with topics in the mainstream Physics units of study offered in first year by the School of Physics. For example, in Semester 1, 2002 the web-based module on waves was used in PHYS1002 Physics 1 (Fundamentals) and in Semester 2, 2002 a version of the fluids web-based module was used in PHYS1003 Physics 1 (Technological).

In addition, such modules have the potential to make the learning of physical concepts an engaging experience in degree programs such as Marine Science and Environmental Science. The addition of a module on Scientific Modelling/Methods would make the unit of study an interesting option for Bachelor of Agricultural Economics students.