Improving Student Learning Grant Report  
Semester 2 2006

Project Title: Introducing ‘deep learning’ concepts to Level 1 students as a means of integrating teaching across discipline areas covered in ENVT 1102 Ecosystem Processes.

Project objectives: Two objectives were articulated in our ISL Grant application. These were first, to introduce ‘deep learning’ concepts to Level 1 students within the framework of understanding ecosystems using the SOLO (Structure of the Observed Learning Outcomes) Taxonomy developed by Biggs and Collis (1992), and second, to use this ‘deep learning’ framework to integrate the disciplines covered within the unit to enable a more coherent and effective teaching program delivery in this unit.

Project strategy: We used the framework of the SOLO Taxonomy as described in Biggs (1999) in each of the three modules of the unit to enable students to understand the depth of learning they experienced. The framework was introduced at the beginning of the unit and students were given illustrative exercises before embarking on the material of Module 1. Module 1 material dealt with land processes and their management. As we progressed through Module 2, which dealt with energy flows in relation to resource management, students were encouraged to critically engage with the material to deepen their learning. Increasing levels of complexity were introduced in the final Module which integrated economic principles into scientific and management issues.

Project outcomes: Throughout the unit, the SOLO Taxonomy remained a common thread, despite different teachers and different teaching styles across a range of discipline areas. Various forms of evaluation, including self, peer and staff evaluations, were undertaken during the unit to encourage students to deepen their engagement and responsibility for their own learning. Students were supported to recognise high and low levels of understanding and given the opportunity to interpret their level of learning relative to SOLO Taxonomy levels. With varying degrees of success, students used the Taxonomy to assess the learning of their peers during the final assessment of the unit. Staff teaching in the unit reported a shift in thinking to view the unit in a holistic manner. Such a shift permits better integration of material and opportunity for students to deepen their learning.

Project dissemination: Dissemination of project outcomes occurred through a Teaching and Learning Forum (2007) presentation (attached) and through the Faculty Teaching and Learning Committee. Longer term benefits of the project include implementing the SOLO Taxonomy into the Terrestrial Ecosystems unit (ENVT
after revision of Ecosystem Processes during Semester 2 2007 and into the future.

We are appreciative of the support provided to ENVT 1102 through the Improving Student Learning Grant, and with thanks we provide an acquittal statement below. Funds allocated to purchase materials for graphic designs and for poster printing of the SOLO taxonomy levels remain unexpended from the project. We will return these funds if required, otherwise we propose to pursue the design and printing of the SOLO taxonomy posters for display in the student laboratories.

**Income**

<table>
<thead>
<tr>
<th>Year</th>
<th>Description</th>
<th>Amount</th>
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<tbody>
<tr>
<td>2007</td>
<td>Improving Student Learning Grant</td>
<td>$2443</td>
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<td><strong>Total</strong></td>
<td>$2443</td>
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**Expenditure**

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<th>Date</th>
<th>Description</th>
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<tbody>
<tr>
<td>18/7/06</td>
<td>Payment to Project Officer (M.J. McPharlane- Staff No. 00040872) for approx 42 hours @ $36.41/hr (ORAA:734A)</td>
<td>$1534</td>
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<td><strong>Total</strong></td>
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**Funds remaining**

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<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>$909</td>
</tr>
</tbody>
</table>

Yours sincerely

[Signature]

Professor Lyn Abbot
28/4/08
Introducing ‘deep learning’ concepts to first year university students for integrating teaching of terrestrial ecosystems

Lyn Abbott, Jo McFarlane and Jo Pluske
Faculty of Natural and Agricultural Sciences, UWA

SUMMARY

- student engagement with the ‘depth’ of their own learning
- SOLO Taxonomy Concept
- SOLO - Past experience (Level 4 students)
- SOLO - Recent experience (Level 1 students)
- Project AIMS and METHODS
- Main Outcomes
- ISSUES
- Acknowledgements
- DISCUSSION

SOLO Taxonomy Concept

<table>
<thead>
<tr>
<th>Node</th>
<th>Structural Level (SOLO)</th>
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<tbody>
<tr>
<td>1</td>
<td>Extended abstract</td>
</tr>
<tr>
<td>2</td>
<td>Relational</td>
</tr>
<tr>
<td>3</td>
<td>Architectural</td>
</tr>
<tr>
<td>4</td>
<td>Procedural</td>
</tr>
</tbody>
</table>

Past experience with SOLO - microbial interactions

Objectives - microbial interactions

- Review information on specific environmental microbiology topics by critical analysis of related scientific journal articles.
- Investigate microbial interactions and identify factors that enhance or limit their effectiveness by planning scientific experiments.
- Identify appropriate molecular techniques for the study of applied microbiological problems.
- Mechanisms
- Clearly communicate research findings in both scientific and lay audiences, verbally and in writing, using a variety of formats.
- Analyze information for and against a range of emotive applications in the environment, constructing well-developed, balanced arguments.

SOLO - microbial interactions

<table>
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<tbody>
<tr>
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<td>Relational</td>
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<td>3</td>
<td>Architectural</td>
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<tr>
<td>4</td>
<td>Procedural</td>
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</tbody>
</table>
Students change terminology to understand the Structure of the Observed Learning Outcomes

<table>
<thead>
<tr>
<th>Mode</th>
<th>Structural Level (SOLO)</th>
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<tbody>
<tr>
<td>Next</td>
<td>5 Extended abstract</td>
</tr>
<tr>
<td>Target</td>
<td>4 Relational</td>
</tr>
<tr>
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<td>3 Multistructural</td>
</tr>
<tr>
<td></td>
<td>2 Unistructural</td>
</tr>
<tr>
<td>Previous</td>
<td>1 Prestructural</td>
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Past experience - conclusion

→ Students engage with THEIR OWN new ideas and deeper levels of investigation
→ Students better understand assessment (and marking) in relation to objectives
→ Students have greater satisfaction (and even excitement) with their own learning

Is this approach relevant in your discipline?

HANDOUT

Ecosystem Processes
First year - environmental studies

Aspects 'well known' - in the news
- e.g. water, climate change, contamination of waterways, food safety, nutrient cycles

Aspects 'less well known'
- e.g. soils, hydrology, drivers of nutrient cycles, economic analysis and decision-making processes

SOLO concept → first year

Application of SOLO concept

1. physical/chemical processes,
2. biological/chemical (energy flow) processes (in context of above) and
3. economic contexts of these processes

→ Students first explain SOLO concept in their own words
Other details
Final section: computer based analysis of the impact and effect on animal production and the environment
- Create a scenario that incurs indirect costs to the community by creating groundwater pollution.
- Very complex - what is the effect?
- What rate of nutrients are added?
- What is the animal's weight gain?
- Determine economic decision criteria over 20 years with and without including indirect benefits and costs

Student understanding of SOLO Concept

<table>
<thead>
<tr>
<th>Level</th>
<th>July</th>
<th>September</th>
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<tbody>
<tr>
<td>Excellent</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Good</td>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td>Moderate</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Forbidden</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Duped</td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td>Trivial</td>
<td>90%</td>
<td></td>
</tr>
<tr>
<td>Zero</td>
<td>10%</td>
<td></td>
</tr>
</tbody>
</table>

Examples of explanations

STUDENT A
- You completely missed the point
- you focused on one part of the question
- State with each part of the question appropriately but fell to put them together drawing their relationships
- Creates links/links between topics to build on the concept. Writing flows rather than being segmented
- Has more confidence to incorporate new ideas.
- Shows large depth in understanding and critical thinking. Ability to use own judgments.

STUDENT B
- Not focused on the task/content
- Able to grasp topic but focus remains on only one area
- Can work with several aspects but in isolation
- Looks across areas, see the big picture
- Fully grasps the given topics & draws on further, external information to enhance understanding

Examples of explanations

STUDENT C
- Point not understood. Look not approached correctly
- Pointed in the right direction, usually find one thing they like to think about but not learn
- Learns individual bits, even with understanding but doesn't get the whole picture
- High school learning understanding of syllabus
- Adding stuff in that furthers the knowledge pool

Assignments related to SOLO

- This assignment was not structured to promote students to think much beyond a subsymbolic level. A total of 26 assignments were submitted and of these, 24 showed that the students were working at a subsymbolic level. The remaining 14 students arrived in early or a subsymbolic level, but probably not any higher than this.
- Students were given a mark out of 10 for the assignments itself but were also given feedback about the SOLO level they were working at. In addition a short paragraph was written on the worksheet 10 going feedback about their answers. In the next task, most of the students were approached one-on-one and their depth of learning was discussed. Finally, all the students were positive about that depth of learning and expressed awareness that they could achieve higher levels as they progressed through their university courses. Some students expressed the satisfaction of getting feedback early in the semester.
Assignments related to SOLO

- **Assignments related to SOLO**

Student comments on their interpretation of the depth of their own learning

- As a student I knew the importance of following the framework of a periodic table and that I understood it.
- I also knew that I had to be clear and precise in my writing, but I couldn't see how the SOLO framework helped me.
- I found it difficult to evaluate my own thinking in this way.
- Sometimes I struggle to compare differences between 2 and 4.
- I think I understand the question well.
- Not so easy to reframe and reframe it as a question.
- It took me a while to understand what was being asked.
- I think I understand how SOLO was used to make me learn.
- I feel I am more aware of the learning process.
- I do not think that I have a good grasp of the concept.
- I have not gained a deeper understanding of how to achieve the objective as I am still thinking about how it was presented.
- I can't fully understand the whole cycle of learning and the relevance of all.
- I have less experience than others in terms of depth and learning.

Peer review of depth of learning

- **Peer review of depth of learning**

- In terms of using the system outlined in the university - does it help students to identify and develop their own depth of learning?
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Issues

- What needs to be done next time?!
SUMMARY

The overall purpose of this activity was to foster a "learning community" model in which students work in small groups to complete assignments. This approach has been shown to enhance student learning and engagement, particularly in science and mathematics education. The project was part of a broader initiative to improve teaching methods in these subjects. The outcomes were positive, with students reporting increased confidence and understanding of the material. The success of this approach suggests that similar strategies could be applied across different disciplines to enhance learning outcomes.

Acknowledgements

~ UWA T&L grant 2006
~ Co-authors
~ Students!!