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Dealing with complexity in education for sustainability – a shared journey for students and teachers in design education

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ABSTRACT

Design graduates must be capable of responding meaningfully to an increasingly complex world. Student learning must provide a holistic and collaborative design practice that is both flexible and creative and authentically incorporates complexity. Within this context it is critical that sustainability, in its broadest definition, is embedded into the curriculum. This enables students to explore sustainability, grapple with issues concerning the interconnectedness of social, economic and environmental considerations in the local and global context, and to better understand the implications of their own actions in the real world. Appropriate teaching strategies are needed to support such learning.

This paper demonstrates how a teaching approach which recognises and values students' existing understandings of sustainability can result in greater learning engagement and support deeper understandings of sustainability in a design discipline context, namely textile design. A case study is presented of the first learning activity to introduce the study of sustainability in a semester long course to develop and apply sustainability learning in design contexts. The learning activity was designed and trialled using a student centred teaching approach. Student interaction during and responses to the activity were noted and compared to teacher past experience and expectations.

The outcomes of the case study suggest a student centred approach enhances learning outcomes in a number of ways. Specifically, valuing individual student's existing knowledge evokes their immediate engagement with the topic and creates a readiness to explore and consider deeper appreciations of the complexity and the diversity of perspectives surrounding sustainability. The activity also provides the lecturer with a clearer understanding of students' existing knowledge base. Consequently the introductory learning activity establishes a more authentic 'starting point' for further learning and transformation.

I. INTRODUCTION

Higher education is a key driver for greater global sustainability (ULSF, 2008). With appropriate curricula and teaching strategies students can develop knowledge, skills and attitudes to apply in professional, community and personal settings to influence change to foster a sustainable future.

Therefore design students need to develop a holistic approach that encompasses both the depth of knowledge of their discipline, as well as the complexity of the environmental, social and economic context in which they design. Education for sustainable development (ESD) can be considered the process of change which seeks to achieve such goals (Leal Filho, Manolas, & Pace, 2009).

Today's students come to university with a range of perspectives on sustainability (Pearson, Honeywood, & O'Toole, 2005), so how should the higher education sustainability learning journey begin? Students who are able to fully engage in learning from the outset, that is, they are 'learning ready' are more likely to achieve better learning outcomes (Wahr, Gray & Radloff, 2009). The first steps for learning for sustainability rely on students being open to question what happens in the world around them. To be prepared to do this, students need an understanding of the complexity of sustainability and purpose of sustainable development (Pavlova, 2009; Ruff & Olson, 2009), and some personal moral or ethical commitment to its achievement (Leal Filho et al., 2009; Pavlova, 2009). Yet, not all students strongly support the need for sustainable development (Ruff & Olson, 2009) nor would all students have the implicit academic skills required. How can students be supported to engage in learning for sustainability?

This paper examines one way of promoting learning readiness and starting the process of sustainability learning. An open-ended activity is used to introduce and complement a lecture series on sustainability. The activity is based around group work and is broadly consistent with what is understood as student centred learning (SCL). Students actively contribute to develop a working definition of sustainability. SCL assumes the position of needing to start 'where the students are', thus students explore and work with their existing understandings. This approach provides an authentic starting point to establish the learning journey to come in subsequent sessions.

II. STUDENT-CENTRED LEARNING

Student learning is best achieved when teachers understand how students learn and how learning is affected by different learning contexts and have a willingness to adapt teaching methods based on these considerations (Bowden & Marton, 1998; Pöllänen, 2009; Ramsden, 2003). Student centred learning (SCL) is a term used variously in the higher education learning and teaching literature to reflect such an approach (O'Neill & McMahon, 2005). The principles that characterise student centred learning have been summarized from the literature by Lea et al. (2003) as:

- Reliance upon active rather than passive learning
- An emphasis on deep learning and understanding
- Increased responsibility and accountability on the part of the student
- An increased sense of autonomy in the learner
- An interdependence between the teacher and learner
- Mutual respect within the learner-teacher relationship
- A reflexive approach to the learning and teaching process on the part of both teacher and learner.

(Lea et al., 2003, p.322)

SCL does not prescribe teaching methods, but rather, teaching methods are chosen to best suit the circumstances of the learning context. However, a number of teaching methods are recognised as consistent with a SCL teaching approach. These include group discussion, group work, projects, student presentations, reflective writing (O'Neill & McMahon, 2005), and more specifically to art and design education, drawing, developing a portfolio, studio practice (Hetland et al., 2007) and making (Pringle, 2009).

III. STUDENT-CENTRED LEARNING & ESD: COMPLEMENTARY APPROACHES

A strong complementarity exists between ESD and SCL. Both emphasise the need for deep learning, action outcomes and acknowledging alternative perspectives and using teaching methods which support this.

ESD principles encourage learning where students are able to apply a holistic (social, economic and environmental) lens to authentic, real world design problems, providing deeper and more complex understandings of issues and thus more efficacious solutions (Leal Filho et al., 2009). Students are encouraged to question the sustainability of the world they interact with and if they find it 'unsustainable', to ask further questions about how this has come about and what actions might change this (Gough & Scott, 2007). Indeed, the "inevitable tension" that can arise from such approaches "can be a driving force for reaching solutions to sustainability issues in higher education" (Wals & Corcoran, 2006, p. 103)

Students who look more closely at causes and effects and start to challenge their own assumptions about previously accepted societal and personal practices are engaging in deep learning as they are "constructing knowledge for themselves" (Gough & Scott, 2007, p. 111).

The following case study uses the principles of SCL and ESD to introduce and engage students in sustainability learning within their design degree. Specifically, this paper seeks to consider the questions: How can a SCL approach be used to introduce design students to the complexity of sustainability? And further, does this SCL approach result in greater learning engagement and support deeper understandings of sustainability in a design discipline context?

IV. THE CASE STUDY

A. Context

All courses in the RMIT University Textile Design degree program contribute to integrating sustainability concepts within design, research and practice. The first year course Textile Technology and Industry (TTI) is core to this as the course aims to introduce and develop the sustainability knowledge and skills that underpin later years. In previous offerings of TTI the starting point for sustainability learning was a lecture in which formal definitions of sustainability established 'by the experts' were presented to students. While discussions were encouraged, they were limited, and effectively directed by the lecturer. With SCL in mind, could a more authentic starting point be found to better engage the student cohort?

B. Methodology

An introductory learning activity was subsequently developed and delivered to the case study cohort (cohort A) prior to them receiving the lecture series. The learning activity was designed with SCL and ESD principles, to value individual student's existing knowledge and foster early and deeper engagement with the topic.

Observing students during the introductory activity and the subsequent first lecture would confirm the level of engagement students had with the topic and help validate the usefulness of the introductory activity's SCL approach. By comparing cohort A, who undertook the activity, with the previous year's cohort of students (cohort B), who did not do the introductory activity, further insight into the usefulness of the activity could be established.

It is noted, however, that there are variables which no doubt also impact on the research outcomes. To be able to ascertain the value of the activity, these needed to be mitigated. Therefore the first lecture was presented in the same way to each cohort and the degree of student

engagement was observed. A comparison of each cohort's engagement in the lecture thus provided a basis to comment on the relative learning readiness of each cohort.

In designing the activity, the principles of SCL were considered. The table (Fig. 1) highlights how these SCL principles formed the pedagogical basis for the activity.

SCL Principle	The design of the activity to reflect the principle
Reliance upon active rather than passive learning	• Objective of task explained to students so students can anticipate tasks • Tasks designed so each student must participate
An emphasis on deep learning and understanding	Activity asks students to: • Identify and articulate own understandings • Listen to other perspectives • Reflect on understandings
Increased responsibility and accountability on the part of the student	• Students engage in open ended tasks • Students work collaboratively to produce a group statement
An increased sense of autonomy in the learner	• Complexity of sustainable development acknowledged by teacher • Students' existing perspectives sought and valued • Students encouraged to give feedback to teacher about the tasks during the activity • Open ended tasks
An interdependence between the teacher and learner	• The need to identify students' 'starting points' on sustainability is explained to students • Group perspective becomes a shared artefact which can be revisited and analysed later in course
Mutual respect within the learner-teacher relationship	• Teacher acknowledges the need for transdisciplinary perspectives and that s/he does not 'know it all' • Teacher is open to suggestions and prepared to make changes on the structure of the task as it unfolds • The tasks require that students listen to the perspectives of others
A reflexive approach to the learning and teaching process	• The task requires students to articulate existing understandings and share these. • The task requires students to
on the part of both teacher and learner	negotiate • The teacher observes student participation in situ and is open to adjusting the tasks to enhance student participation

Fig. 1. How the principles of SCL were applied to the introductory learning activity

C. The Activity

The introductory learning activity involved 30 first year textile design students (cohort A) participating in a two hour session (tasks 1-3) and a post-session task (task 4). The overall aim of the activity was for students (by the end of the session) to have explored their personal understandings of sustainability and to develop some shared group understanding of sustainability. To achieve this, students were asked to;
i) Reflect upon their existing understandings of sustainability.

Task 1: Individually, each student came up with ten words or ideas in response to the question '*What does sustainability mean to me?*'. Individual answers were written on separate post-it-notes. It was emphasised to students that there were no right or wrong answers.

ii) Compare and contrast their personal understandings to the understandings of others.

Task 2: Sharing task. In groups of five, each student reported their words/themes to the group. Students were asked to look for commonalities and connections between each others' words/themes. Each group nominated ten words/themes that summarised the group's understanding of sustainability. Responses included words, diagrams and schematics.

iii) Contribute to the development of a shared class meaning of sustainability

Task 3: Responses to task 2 were compiled for the whole class, see (Fig. 2). Students were asked to reflect and comment on the list. Facilitators prompted the class with questions, such as: Did any word/s surprise? Were there any gaps? What did the use of common words suggest?

To finish each group shared their negotiated list/ visual representations with the entire group and briefly explained the arrangement of their themes/words, their visual representations and their meaning. The list was digitised and made available to students on the course Learning Management System (LMS) after the session.
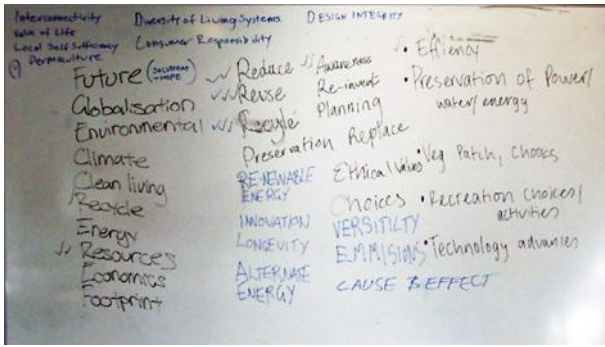
Fig. 2.   Compiled List

iv) Individually reflect on their understandings

Task 4: Students individually reflected on the activity and their understandings of sustainability post the group session. Students were required to write a statement to explain what sustainability meant to them.

D. Observations & Reflections on the Activity

Students started task 1 tentatively. As they put down their ten words, some commented they could not think of enough. Students were reminded there were no incorrect ways of responding to the task and encouraged to keep going. Every student ended with ten words.

During task 2 there was active discussion within groups. Students provided detailed explanations about their choice of words. Students negotiated with each other to achieve a collective agreement.

Whilst compiling the group meaning some participants used visual images, rather than the written words generated earlier. This had been unanticipated, but on reflection seemed a natural way for design students to express themselves. We suggested to other groups that visual representations could help them to express how their ideas might interconnect.

Some groups started developing visual metaphors to explain their understandings of sustainability. Seeing this, other groups also developed their own metaphors. Providing marker pens allowed students to express themselves in more intuitive ways demonstrating a deeper and more relational concept of sustainability.

During task 3 the studio was a cacophony of 'on task' noise. Individuals within each group called out words to be written up on the board and others commented as new words were added to the list. The words ranged from simple conceptions (e.g. renewable energy and recycle) to quite sophisticated (e.g. longevity and consumer responsibility). The phrase 'cause and effect' was noted by students and led to a strong discussion about the impact of design and consequently the role and responsibilities of the designer.

As each group presented their personal understanding of sustainability and their metaphors there was spontaneous applause for each group's contribution. Students seemed to enjoy each presentation. They wanted to encourage each other and valued each others' contributions. Throughout tasks two and three, students appeared enthusiastic, were highly collaborative and wanted their ideas to be heard. They appeared to be having fun. The group dynamic indicated a high level of student engagement.

Of the 30 students in the class, 28 provided a personal reflection as per task 4.

IV. DISCUSSION

The introductory activity allowed students to actively grapple with the complexities and debates surrounding sustainability. The following section discusses how students engaged in the activity and how this relates to student centred learning:

A. Active, Not Passive

The session was particularly useful for students who lack confidence in their own knowledge or opinion. When gently challenged, these students could observe that every opinion mattered and they had as much to contribute to the discussions as those students who were more confident or seemingly knowledgeable. A student from cohort A shared the following reflection:

> "I found this exercise very helpful and interesting and by being in small groups rather than a whole class combined, people could talk more and generate more ideas easier and also it was more comfortable to talk in small groups rather than in front of everyone."

This contrasted to previous course offerings in a lecture format. While questions and discussion within the class were encouraged, only the most passionate and confident individuals spoke up.

B. Learning Environment

The learning space was rearranged to indicate to the students that this activity was a different type of session to a lecture presentation. The space lent itself to the active and reflective SCL approach used. The smaller group work took the discussion to a deeper level than achieved through the lectures given in previous years.

C. Negotiating Meanings

The initial list of 60 words was reduced to ten. Students needed to negotiate and discuss ideas, meanings, and importantly relationships between these words and their relative value. They were looking for commonalities and shared meaning, from which they would be prepared to agree to compromises. Providing this opportunity to discuss allowed "learners to acknowledge contrasting

views and reflect upon their own position." (Cotton et al., 2007, p. 594)

D. Sustainability Embedded In Design Practice

The 'cause and effect' discussion mentioned earlier demonstrated cohort A students developed an awareness of the importance of embedding sustainability and that sustainability thinking was integral to their design practice if it was to be meaningful. The phrase 'cause and effect' and the responsibilities of the design was to become a central theme as the learning moved towards developing a framework for applying sustainability principles to textile design practice throughout the rest of course. The relevance of studying sustainability seemed to be clear to students.

E. Developing Complex Understandings

The discussion required students to think critically about complexities and relationships between sustainability concepts. Students later reported the tasks had started off being 'really easy', but as the activity progressed the tasks required students' engagement to become academically more complex and challenging, consistent with the Structure of the Observed Learning Outcomes taxonomy (Biggs & Tang, 2007).

Each activity scaffolded students to take further steps in their reflections. Each group had to list, sort (compare & contrast), translate and condense ideas into higher order themes, identifying and re-evaluating linkages between the words. For example when one group (Fig. 3) started to arrange their ten words on the paper, the interconnectedness of the words became more evident to students, and they began to develop a far more complex understanding. Ultimately, when students incorporated metaphors into their understandings they were demonstrating highly sophisticated and abstract thinking.
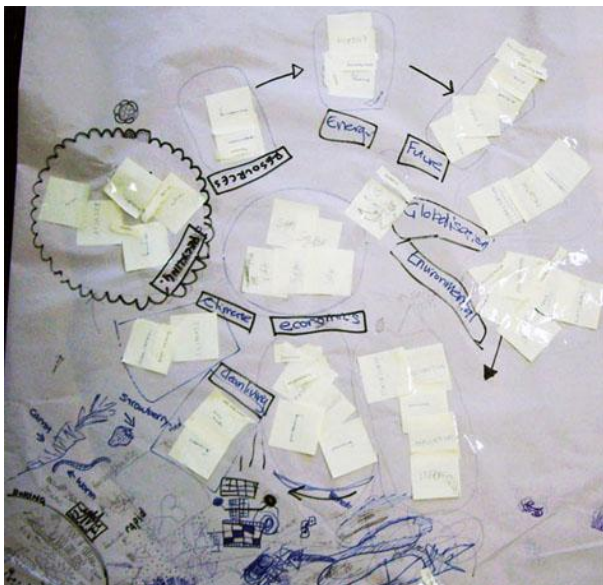

Fig. 3. Example of group outcome

The metaphor students proposed was that sustainability was 'like a giant washing machine', that was driven at the centre by the sun (& solar system) and around this centre rotated different elements; the key themes. As the students presented, they made it clear each independent element was also interdependent and connected to each other. Each element moved, both towards and away from the centre and around the centre, and at different speeds. This was a highly complex conceptualisation that the students themselves had arrived at, owned and expressed passionately.

A diversity of perspectives was to be expected. Not every group presented ideas that suggested deep insights about the complexities of sustainability. The activity did, however, expose these students to the more sophisticated perspectives of their peers. And that the vast majority of students engaged fully demonstrated to the entire group that the ideas presented were clearly meaningful and personally significant to that student.

F. Starting Points & Ongoing Engagement

From a teaching perspective, this exercise provided a far greater insight into students' existing perceptions associated with sustainability. Each task provided the teacher with further insights into student thinking and their capabilities to analyse and critique ideas as well as communicate them.

There were also some insightful unexpected opportunities presented in the activity. For example, 'sustainability is boring', was written in the bottom of one group's list. This is a genuine student perspective and should not be ignored. If students hold this view, the lecturer is then challenged to find ways to engage them.

G. Post Activity

The value of the introductory activity could be further considered by comparing the first formal lecture of cohort A, who undertook the activity, with cohort B, who in the previous year had not undertaken the introductory activity before commencing the lecture series.

In the first lecture, when definitions of sustainability were presented, cohort A students' tended to have more confidence to ask questions and to express opinions. In contrast cohort B students, who began with learning about the formal definitions of sustainability 'by the experts' were more passive, and accepting of these as the 'answer'.

In addition, as stated the 'cause and effect' discussion became an important theme that cohort A students would regularly return too. By linking the early formal sustainability lecture to the student's own concepts that emerged from the SCL activity engaged these students more enthusiastically. This was evident in the number of students involved in class discussions in the first lecture, and also the body language of students who may not have verbally participated, but who were nodding in agreement

or disagreement at what was being said. In the previous year, cohort B had been more passive and quiet. It took considerably more time for the cohort B students to make complex connections between the role of designers and sustainability compared with cohort A. This suggested cohort A, were more 'learning ready' compared to cohort B due to the learning activity.

V. Conclusion

Teaching needs to take into account the student cohort. Acknowledging the diversity of students' backgrounds, points of view and prior experience ensures an authentic and meaningful learning experience, which assists to engage students more deeply with sustainability principles. Having students develop a personal definition of what sustainability means to them through the introductory activity provided students and the lecturer with a significantly more meaningful entrée to engage more fully with the course material and importantly a preparedness to grapple with the complexity of sustainability.

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