Enabling authentic cross-disciplinary learning through a scaffolded assignment in a blended environment

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This paper reports on the development of a scaffolded learning assignment with blended components in a cross-disciplinary setting. The assignment has been developed in a socio-cultural context, based on a Vygotskian approach and this paper details the design and development of the assignment. The five stages of the assignment have been carefully scaffolded and include elements of individual and group tasks, finishing with an individual reflection on the process. Formative assessment and associated feedback are important elements of the scaffolding and suggestions for further applications for the learning design of the assignment are suggested.

Keywords: Scaffolding, blended learning, authentic learning task, formative assessment

Introduction

This paper describes the design and development of a scaffolded assignment in a compulsory postgraduate subject at an Australian university. The subject involved cross-disciplinary learning requiring engineering students to become competent in the area of financial management. Previous assignments in earlier offerings of the subject were met with student disinterest and poor performance, so the desire this time was to provide an authentic learning task (Herrington & Oliver 2000) that would both engage the students and improve their learning experience.

Consideration was given to the importance of collaboration (Pifarre 2007) , multiple methods of assessment including both formative and summative components (McMillan 2000) , social interactions, feedback to students (Sadler 1998; Shephard 2006) and strategies that would be appropriate to utilise the benefits of a blended learning environment (Dabbagh 2003; McLoughlin 2002). As a result a Vygotskian approach with a strong emphasis on scaffolding was adopted as the pedagogical framework for designing the assignment. This ensured that the assignment would be student-centred with many opportunities for interaction with others at individual, group and class levels.

The next section discusses this theoretical focus. The third section provides an analysis of the need for the scaffolded assignment including strategies adopted in its design. The paper then describes how the assignment was developed and introduced to students, with a detailed evaluation of the implementation to be presented in a later paper. The final section provides suggestions of how this learning design is readily adaptable to other cohorts of students across various subjects.

Theoretical focus

A Vygotskian approach was adopted in this subject and assignment with a strong emphasis on scaffolding. Vygotsky is widely regarded as the founder of a sociocultural framework for learning in which the ability of students to interact with others is a central principle (Hall, 2007). Vygotsky's core assumptions about learning include

- the notion that "social interaction plays a fundamental role in the development of cognition" (Kearsley, 2008)
- concepts should be taught before they are used in activities (Hall, 2007)
- good learning is that which is ahead of actual development (Hammond & Gibbons, 2001)

- higher order functions develop out of social interaction (de Valenzuela, nd)
- optimal learning occurs within the Zone of Proximal Development (ZPD) which can be defined as "the region that lies beyond the learner's independent problem-solving skill, but still within reach with the right support" (Bonk & Kim, 1998, p70.)

In the 1950s, Bruner extended these ideas and further developed them through the introduction of scaffolding. His original context was oral language acquisition in young children. Since then scaffolding has evolved to encompass the wider provision of sufficient and relevant supports to promote learning more generally.

There are many definitions of scaffolding that have been developed over the past 50 years, and this paper will use that advanced by Dickson, Chard & Simmons (1993, p.12), that scaffolding is "the sequencing of prompted content, materials, tasks, and teacher and peer support to optimise learning". This definition includes all of the elements that differentiate scaffolding from other types of learner support. Its only limitation is that it does not mention the temporary nature of scaffolding (Benson, 1997) whereby scaffolding involves the withdrawal of support over time to develop individual student mastery.

Various strategies have been suggested to improve the effectiveness of scaffolding (Chen & Bradshaw, 2007; Dabbagh, 2003; McLoughlin, 2002) with some being identified as more appropriate to the face to face environment and others to the online environment. A later section details how some of these strategies were incorporated in this assignment. McLoughlin (2002) comments that many of the same principles of scaffolding apply in face-face and online learning situations, citing the well-known concept of e-moderation as developed by Salmon (2001). She discusses the notion that there are many different types of support available for students through the utilisation of technology. These include "encouragement of reflective thinking, provision of social support for dialogue, interaction and extension of ideas with feedback from peers and mentors on emerging issues" (p. 152). Each of these details is explored in the design of the assignment on which this paper is based and is discussed in more detail in following sections.

As this assignment was delivered in a blended learning environment, students received support through scaffolding in both the face to face and online environments which required careful consideration to ensure that the right blend of support was provided and that scaffolding had been correctly timed. The pedagogy of a blended learning environment is "based on the assumption that there are inherent benefits in face-to-face interaction as well as the understanding that there are advantages to using on-line methods" (Clark & James, 2005, p. 19). It has been suggested that such an environment promotes student-centred learning and encourages increased student interaction (Carmody & Berge, 2005; Davies & Graff, 2005; Gallini & Barron, 2002).

Such findings indicate that simply converting a traditional face to face course into an online delivery format does not necessarily improve student outcomes. To achieve gains in student outcomes, online learning components must be included in order to adopt a student-centred pedagogy. It has been suggested that, rather than an "add-on" approach, there needs to be major redesign to make "the teaching-learning enterprise significantly more active and learner-centered" (Twigg, 2003, p. 30).

Yoon and Lim (2007) stressed the importance of designing a blended learning course with the why and the how at the forefront. Thus, an appropriate definition of blended learning is "an optimal combination of face-to-face and online education that improves learning and the satisfaction of instructors and students" (Bourne, Harris & Mayadas, 2005). In addressing why educators choose to introduce a blended approach, Graham, Allen and Ure (2005) found that two main reasons were improved pedagogy and increased access and flexibility. (See also Williams (2002).) A blended learning environment "aims to enable students to take much more responsibility for their own learning by focussing on *what the student does*" (Subic & Maconachie, 2004, p. 35). By using action learning and reflective practice, blended learning promotes the adoption of deep approaches to learning, which is facilitated by group activities.

Formative assessment can be a powerful tool for moving learning forward and this form of assessment has close links to scaffolding and ZPD. Positive learning outcomes occur when feedback focuses on the features of the task and how to improve in relation to learning outcomes (Shephard, 2006). The ultimate aim of assessment for learning is that "students continue learning and remain confident that they can continue to learn at productive levels if they keep trying to learn" (Stiggins, 2002, p. 762). With adequate feedback, there are many things to be learnt from appropriate assessment tasks. The main way to ensure that assessment is *for* learning as well as *about* learning is to increase the amount of formative assessment and create more of a balance between this and the summative assessment.

The main advantages of formative assessment are that it provides opportunities for students to receive feedback on their performance, build on their strengths, improve areas of weakness and thus enhance their learning. Constructive feedback needs to be timely, informative and suggest ways the student can move forward. How this feedback is conveyed, and language used is just as important as what is included in the feedback (Sadler, 1989), partly as inappropriate feedback can have a negative effect on a student's learning. There is consensus in the literature that feedback needs to encourage positive self-esteem and inspire confidence and hope in students (e.g., Clegg & Bryan, 2006; McMillan, 2000; Sadler, 1989). This can be achieved by ensuring that the feedback offered includes valid criticism as well as appropriate praise and commentary (Brown & Knight, 1994).

The formative nature of each stage of the assignment meant that its aim was not only "to 'quantify' a student's performance in terms of the number of 'facts' they are supposed to acquire" but also to help them to understand "the processes through which they arrive at certain conclusions in solving a given task/problem" (Di Napoli, 2004, pp. 2-3). Maclellan's findings that "students do not exploit assessment to improve their learning" (2001, p. 317) suggest that students need to be better educated into the value of assessment as a tool to further their learning. There is also a need to fully communicate with students about the rationale for different assessment tasks and types.

The assignment drew upon three of the principles of effective assessment listed by McMillan (2000) as particularly relevant to the design of high quality assessment for learning namely: good assessments use multiple methods, good assessment is efficient and feasible, and good assessment appropriately incorporates technology.

The case study assignment afforded an avenue for students to participate in group work, both face-to-face and online. In addition, there were individual elements which had to be submitted online in which students reflected on the performance of both themselves and their fellow group members, and assessed each individual's contribution to the project. As found by McAlpine, Reidsema and Allen (2006), the process of completing this feedback improved students' awareness of group processes and helped them to understand the need to contribute effectively. This feedback also provided valuable data that could be used as part of the overall assessment of the assignment (McGourty, 2000). In addition, the online nature of the submission offered a confidential medium through which students could submit their peer assessment. Previous research has also indicated that by adopting a student-centred blended learning approach, both student motivation and student grades can be improved (Abraham, 2008).

Background to the assignment

The subject

The assignment was set in a compulsory postgraduate subject in which engineering students were required to show competence in the area of financial management. Engineering is comprised of both physical and economic components as shown in Figure 1. Thus, engineers are required to place their project ideas within the larger framework of the environment. They must ask themselves if a particular project will offer some net benefit to those who will be affected by the project, after considering its inherent benefits, plus any negative side-effects, plus the cost of consuming natural resources, both in the price that must be paid for them and the realisation that once they are used for that project, they will no longer be available for any other project. The implications of this is that engineers must be able to decide if the benefits of a project exceed its costs.

The students

Since the new student cohort in 2007 was expected to be similar to the previous 2006 group, close attention was given to the characteristics of these previous students in designing the assignment. The class consisted of 46 students with an age range of 21 to 57, with a mean age of 28 and a median of 30, meaning that most students had experienced the realities of budgeting, borrowing and income tax, and thus felt they were somewhat familiar with the financial world. There were both Australian and international students as shown in Table 1, with all of the international students having completed their undergraduate engineering degrees at universities outside Australia. However, all the students discovered that accounting was like another language (with even the Australian students finding that the meaning of "cash" was different to their previous understanding), but in addition, the international students had to overcome a double language barrier since the same accounting terms mean different things in different English speaking countries (for example "stock" and "capital" have different meanings in Australia, the United Kingdom and the USA). Thus, it was extremely important that there was adequate support for the

students in the early stages of the assignment, so that they would clearly understand what was required of them.

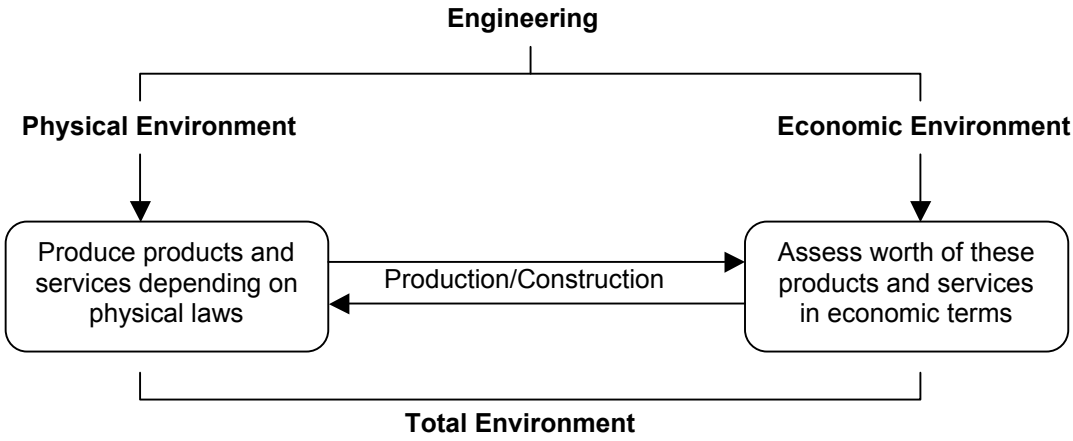

Figure 1: Physical and Economic Components of an Engineering System

Table 1: Nationalities of the previous 2006 cohort of students

Nationality	N (total = 46)	%
Australian	18	39.1
Chinese	10	21.7
Indian	8	17.4
Other Asian	2	4.3
European	5	10.9
South American	3	6.6

The assignment

There were three types of assessment components in the previous offering of the subject: online questions and tests, two assignments based on short case-study questions in the textbook – the first consisting of two cases and the second of three cases, and a final exam. Although these assignments centred around case studies, the students were only required to read the cases and answer the questions, with no original discovery or research required. Thus, because of the question-answer nature of all components of the assessment, there was little opportunity for students to show initiative, nor the opportunity to engage in work apart from that contained in the textbook. Furthermore, since the only individual component of the assignment was a reflection at the end, students had not thought about the assignment before their first group meeting, so there was no synergy.

It was decided that in the next offering, the subject would have one larger assignment divided into five stages as shown in Table 2. Both the first and last stages would require individual work, which meant that students would not only be reflecting at the end, but also thinking through assumptions that needed to be made and researching where information could be gathered, whether online, from books or magazines, from interviews, or from other sources. Consequently, at their first group meeting, each student had something to share – both their own contributions and the feedback they had received for Stage 1.

By using a case study for the assignment, students were provided with vicarious experience as a basis for learning. Unlike lecture-based teaching of theoretical concepts where the instructor does all the interpretation, using a case study promotes problem solving skills by encouraging students to directly interpret the facts and dilemmas of a "real life situation" of the sort engineers face in their professional lives. Such an approach has three major advantages. First, it forms the basis for development of analytical and problem solving skills. Second, it provides an avenue for exploration of solutions for complex issues. Third, it allows students to apply new knowledge and skills. Together, these three provide a firm foundation for the acquisition of the desirable graduate qualities that promote life-long learning.

Table 2: Distribution of assessment components in two offerings of the subject

	Previous Assessment Structure		Proposed Assessment Structure	
Component		*%*		*%*
Questions	Weekly questions	10	Weekly questions	0
	Online tests	10	Online tests	15
Assignment	Assignment 1 Group	20	Stage 1 Individual	10
	Assignment 2 Group	25	Stage 2 Group	5
	Individual	5	Stage 3 Group	30
			Stage 4 Group	5
			Stage 5 Individual	5
Exam	Final exam	30	Final exam	30

Assignment design

This approach demanded students to recognise the complexities of the situation, that many factors contribute to decision making and that variables interact over time. The assignment was designed to engage the students by allowing them to gather and present information in a variety of ways, and from the viewpoints of different individuals and different groups. Such an assignment would enable students to use the advantage of hindsight to gather information that would be relevant in the present. Although each group had to come to a decision, there may not be a single, clear cut solution, thus encouraging further enquiry and debate.

Successful design of such an assignment would need to incorporate multiple methods of assessment including both formative and summative components, social interactions and feedback to students. In addition, the assignment was designed to maximise the advantages of using a blended learning approach in order to implement the scaffolding strategies by incorporating the benefits of both face-to-face and online elements. Table 3 illustrates the strategic considerations that were used to maximise the effectiveness of scaffolding in the two media. Feedback was provided at every stage, and social interactions occurred both in small groups and in the class as whole.

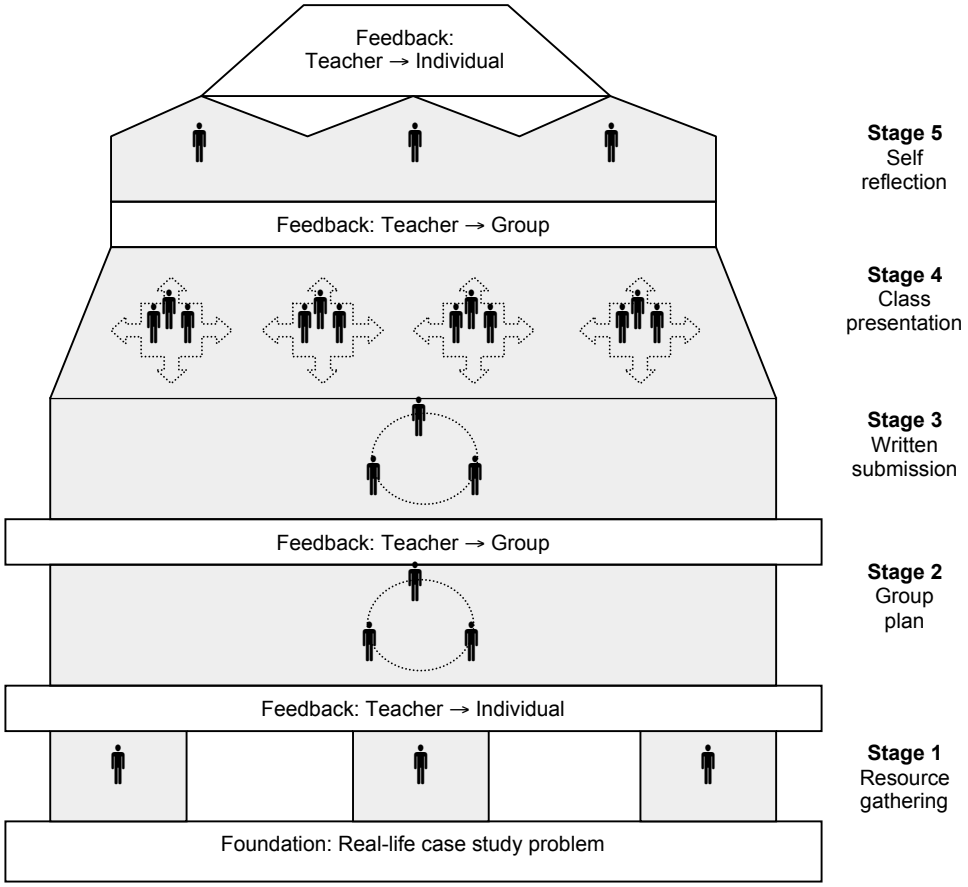

Figure 2: Scaffolded assignment stages

By designing a financial assignment which related to a specific engineering context, consideration was given to the central tenet of ZPD, that students could be extended to learn beyond their normal problem-solving range by providing appropriate support. Thus a scaffolded structure was regarded as essential in accomplishing this cross-disciplinary learning. The final design of the assignment is encapsulated in Figure 2.

Table 3: Assignment scaffolding strategies in a blended environment

Strategy	Description	Face to face	Online
Orientation – communication of expectations	Students are provided with a clear description of what they should achieve and what is the target performance	Detailed explanation of task and learning outcomes provided in workshop	Information provided online: detailed assignment, marking guide, submission instructions
Setting the class tone and forming the groups	Establishing an atmosphere of trust and open and friendly community of learners	Icebreakers, time given in first workshop to form groups	Introductory posting from coordinator; students sought group members on discussion board if necessary
Coaching students in problem-solving activities and learning tasks	The learner receives support to help performance of a task	Help before submission and feedback provided after each assessment	Students communicating on discussion forum about expectations and problems; Seeking clarification from both academics and other students. Summary of expected solutions and common errors post assessment stages.
Modelling thinking aloud process	Articulation is encouraged in order to express current understanding and reflection	Group tasks In class presentation	Group tasks, discussion forum
Expert regulation	Support is based on provision of expertise by an expert or mentor, showing examples and desired learning outcomes	Feedback provided by academic on all submitted work at each stage	Journal article relating to similar case study. Rubrics provided. Individual feedback summarised and communicated to class.
Conceptual scaffolding	Help is provided when the problem or task is presented to encourage learners to focus on problem definition where there may be multiple interpretations	Detailed explanation of task and learning outcomes provided in workshops and consultation Feedback provided after each stage allows learners to correct any misconceptions	Summary of expected solutions and common errors
Metacognitive scaffolding	Enables learners to record their thinking while engaging with the actual problem	Individual reflection on both process and content	Online submission of reflection
Procedural scaffolding	Supports learners in using available tools and resources	Detailed guidelines provided in subject outline and in class	Detailed guidelines provided in online documentation
Strategic scaffolding	Emphasising alternative courses of action and learning pathways that may be applied in classroom settings	Continual references to assignment task in relation to weekly material. Oral presentation by each group to class	
Promoting interaction and collaboration	Promoting interaction and collaboration	Group assignment Synergistic input	Discussion forums

Source: Adapted from Dabbagh (2003) and McLoughlin (2002)

Assignment implementation

The new assignment was implemented with the 2007 student cohort. The initial introduction mode was via the subject outline which was distributed in the first face-to-face class and also available on the subject website. Students read that

> This is a scaffolded assignment with five stages spread over the session. Feedback and/or marks will be provided at each stage. The total assignment is worth 55% of your total marks for the subject. The following table provides a summary of the nature, submission mode and value of each stage of the assignment.

Stage	Nature	Submission mode	Value
1	Individual	Online	10%
2	Group plan	Online	5%
3	Group assignment	Written hard copy	30%
4	Group presentation	Online PowerPoint slides Oral presentation	5%
5	Individual reflection	Online	5%

Next, students were handed a printout of the full assignment which was also available on the website. This was the point at which students received their first explanation of what they were required to accomplish by completing the assignment:

> This case study provides an opportunity to demonstrate your mastery of the basics of financial analysis as covered throughout the subject. The project will be completed in groups of 3 students, but there will also be individual components of the assessment both at the beginning and the end.
>
> **The financial decision**
> The case study is a replacement analysis for your personal motor vehicle. You must consider two options and two funding alternatives for each option. The options are a used vehicle or a new 2007 model of a comparable vehicle. The two funding alternatives are cash purchase or leasing.
>
> You must utilise actual current Australian data sources to the maximum extent possible; e.g., your credit union or bank for loan rates, and estimates from appropriate websites, publications or local businesses to determine the operating expenses of vehicles, for salvage values on your existing vehicle and other relevant variables.
>
> To assist you in determining relevant variables, the following article from *The Engineering Economist* has been provided as an e-reading on the subject website:
> Hartman, J.C. (1998) "Automobile Replacement Case Studies for Engineering Economy Classes", *The Engineering Economist*, 43 (3): 278-289.

After some discussion of the assignment in general, students were given a printout of the requirements for Stage 1 which were then covered in detail. This was followed by an informal time where students had the opportunity to meet each other and form groups. Students who failed to attend the first class were able to download all the handouts from the subject website. To find a group, some of these students posted notices on the discussion board, while others waited until they attended class the following week.

Although this paper focuses on designing the scaffolded assignment, it is interesting to reflect on some of the feedback the students provided in Stage 5. The overall responses were positive with students recognising the contextual learning to which they had been exposed. It was very pleasing to note that the aim to provide a real-life situation with which the students could identify was met as demonstrated by the student comment that

> the major assignment was difficult at times but quite interesting and applicable to real life.

It was also satisfying to have students recognise that the subject was providing them with tools which they could then apply in the assignment, as seen in the following comments:

> The assignment enabled a real application of the tools of Economic analysis taught throughout this subject. For this particular subject this was very important as most problems

> in the text deliver the variables to allow calculation. Sourcing the variables is more comprehensive and is more representative of how to address economic analysis in industry. This assignment was beneficial in drawing together all possible variables and using these in conjunction with methods of economic evolution to deliver a quantitative approach to economic decision making.

and

> It gave me a better understanding of the basics of financial analysis that was covered throughout the subject. It allowed me to incorporate what I learnt into an assignment and that was really beneficial in understanding key information. The replacement car project is a really good assignment as many of the students in the class will, at some stage, buy their first car and now they have this information it will assist them in making a better decision

In addition, students reflected on what they had learnt from the group experience:

> I learned to understand more other group members. The interesting thing is that you always work with different kind of people and sometimes culture, and this enriches yourself with more knowledge and comprehension

and

> I found that that discussing the question as a group enabled me to draw from other members understandings and incorporate them into my own. I also learnt to respect other people's point of view a little more and to be more open minded to suggestions.

Such positive feedback on the group component of the assignment confirms the need to include this in future versions. Whereas students formed their own groups, consideration could also be given to the benefits and challenges of pre-assigning students to mixed cultural groups. Students also made useful suggestions which have been used to modify and improve the 2008 version of the assignment, such as giving more upfront information about the difference between "assumptions" and "variables" in Stage 1 and how to justify these assumptions in Stage 3. In addition, more time was spent ensuring that students had read and were familiar with the detailed marking guidelines prior to their submission of each stage. Although final marks for the revised assignment are not available, these variations appear to have improved student outcomes in terms of their engagement with the assignment and their readiness to explore new avenues of financing.

Re-usability of learning design in other contexts

It is anticipated that this learning design will be readily adaptable and accepted by a range of disciplines and any subject that is looking to incorporate a group assignment in a blended learning approach. The generic nature of the assignment design and the articulation from individual to group to full class to individual tasks within the assignment has a wide application across disciplines. For instance, this learning design being embedded in a case study lends itself to ready modification for use in other accounting, engineering and technical subjects.

In addition, with implementation modifications, this learning design could be adapted for use in distance learning with no face-to-face component. However, suitable substitute technologies such as video-conferencing or Skype would need to be included to achieve personal connections between the students and provide opportunities for feedback from small groups to the whole class. Consideration could also be given to the development of an online blog by each group, which could provide both a basis for interaction between the members and feedback to the instructor.

One of the key features that is readily transferable into other contexts is encouraging authentic learning, by giving students an assignment which is designed to build and assess their ability to apply knowledge and skills to real-world challenges.

Concluding remarks

This paper has described the design and development of a five stage scaffolded assignment in a blended learning environment. The assignment was developed using a socio-cultural framework, based on a Vygotskian approach. The context and content of the assignment have been discussed including its initial

implementation. It has been noted that the assignment was favourably received by students, whose reflections and suggestions will be further analysed and used to modify the assignment when it is next offered. This will help ensure that students continue to engage with the assignment and subject and meet the associated learning outcomes. Although set in a cross-disciplinary context, the assignment design could equally be applied in any discipline or subject in which the concept of student-centred scaffolded learning is valued.

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