



Scientia Education Investment Fund Grants Final Report

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Developing an assessment framework for large online cyber security courses to maximise student engagement

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1. Executive Summary

This project involved the design and implementation of a pilot assignment framework for ZEIT 8032 Information Assurance Principles (IAP) – a large cross-disciplinary online course within the Masters of Cyber security programs. Aligned with the UNSW's 2025 strategy on developing a distinctive model of education (UNSW 2025) and the Scientia Education Investment Fund (SEIF) priorities, the primary aim of this project was to provide innovative course design for a diverse cohort of students. This was done by scaffolding the core assignment components using educational technologies which support student flexible learning and have a capacity to enhance student online experience, resulting in better student assessment outcomes and course satisfaction.

Based on the Project Leader's preliminary knowledge from 2016 IAP offering and student feedback, initial plan was to design a course curriculum including summative online assignments which would enable deeper research into students' learning through online engagement. We focused on a Case Study - a summative assignment comprised of online forum discussions on a chosen case, followed by a peer evaluation of fellow students' contribution. Students are then expected to reflect on what they have learned and summarise their understanding into the scaffold assignment – a Case Study presentation.

Following the described plans, a comprehensive literature review and evaluation of 2016 survey data has guided the development a pilot framework (Fig.1). The framework was implemented for IAP 2017 offering and evaluated using mixed-method of qualitative and quantitative approach. The data was collected from both anonymous surveys: mid-semester evaluation and an official UNSW end-of semester *MyExperience* survey. Series of interviews with tutors, lecturers and students' focus groups were also conducted. Data from these interviews was analysed using NVivo 11 Pro. The framework was also tested using statistical analysis of online discussion forums and student results, based on the hypothesis that students who gained a deeper understanding of the course material through online discussions were more likely to perform better in assignments.

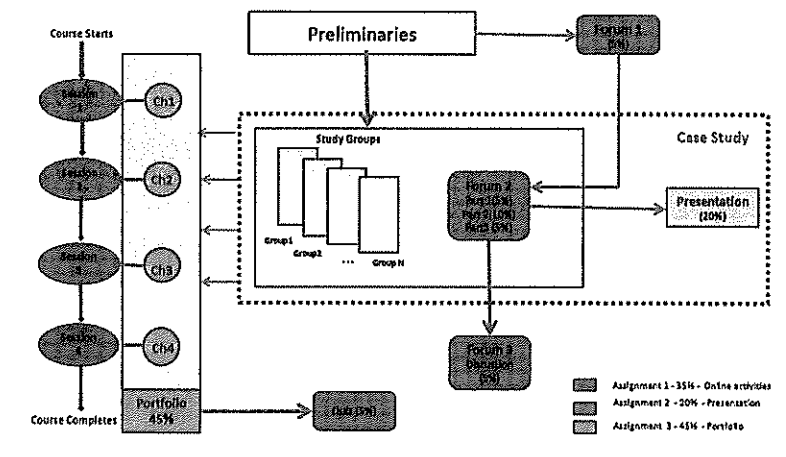


Figure. 1. A Pilot framework

The key findings for this project are:

- The pilot framework developed for 2017 IAP generally proved to be reliable and beneficial for students.
 - The statistical analysis of student results demonstrates that when assessment is linked to group online discussion forums (ie. assessment is scaffolded), students achieve on average, higher overall grade than students from 2016 cohort.
 - The machine learning based model developed successfully predicts student final results based on their online engagement.
- However, this research
 - showed a way to gain deeper understanding causes of student dissatisfaction and hence more effective ways of addressing them over time; and
 - reiterates that creating effective online group assignments needs time and assumes skills and qualities that many educators will need to develop and practice.

2. Outcomes and impact

This project is aligned with the UNSW's 2025 strategy on developing a distinctive model of education for students with different academic backgrounds, ranging from very technical to non-technical disciplines; and the Scientia Education Investment Fund (SEIF) priorities. It also addresses four of UNSW teaching and learning pillars: (1) diversity of the community, (2) students feedback, (3) innovative teaching and (4) use of digital resources. It is built upon the importance of listening to students' voices and implementing their feedback (survey results from IAP 2016). This project has implemented innovative ideas to encourage student online engagement by developing a pilot framework including scaffolded assignments using digital resources provided through the online Moodle discussion forums.

Below are the key project outcomes:

- We found that online group engagement had a positive effect on students' results in 2017 in comparison to 2016. Initial findings demonstrate that after implementing a pilot with revised assessment structure in 2017, students gradually improved their skills and understanding of the course material. In fact, in 2017, when assessment was linked to online discussion groups (i.e. scaffolded), aspects of online engagement became predictive of overall grade and student performance in their assignments.
- We were also not surprised by the accompanying negative impact the online group engagement has had on student overall course satisfaction. From 2016 to 2017 it declined by 7.2% (*MyExperience*). This is difficult to statistically analyse due to the large-scale standardising and anonymous approach that University takes. We believe that innovative teaching and learning initiatives tend to challenge the established cultural beliefs and students tend to dislike them due to lack of familiarity. However, students are likely to appreciate its benefits over time. Encouragingly, the recent 2018 *MyExperience* survey showed that the overall course satisfaction score increased by 13.8% compared to 2017 results and 6.6% compared to the first course offering in 2015.
- The machine learning based model developed successfully predicts student final results based on their online engagement. We have trained 46 different classifiers and three accuracy measures are calculated over the test data, namely, precision, recall and F-measure. By fixing value of recall to one, we have found four models with precision 0.77 and F-measure 0.87 which are acceptable. As such, we are surprised at the *MyExperience* results, since the traditional belief is that better grades lead to greater student satisfaction. This does not seem to be the case for IAP. Therefore, deeper analyses are required to understand this inconsistency between high grades and poor course evaluation results.
- We believed that students can complement each other's diverse skills through the participation in online group assignments. Group assignments however, do not always achieve desired outcomes, posing challenges for both instructors and students.
 - Students often experience frustration when working with fellow students who participate sporadically or drop out of a course late.
 - Course instructors also face challenges in encouraging student participation and re-arranging groups.
- There is no "one size fits all" approach that can be applied to all online course assignments to encourage student engagement. Creating online group assignment needs time and assumes skills and qualities that course instructors and educational designers may need to develop and practice. We hope that results from our experience encourage and support other educators facing similar challenges with online group assignments and student engagement.

As such, if we can continue understanding student online engagement in online discussion forums, we can construct better curriculum – particularly online group assignments – which could lead not only improved student final results but also to better student satisfaction.

The major impact that this project has had is that our approach measures and improves upon an assessment design as is currently implemented in several post-graduate courses. The Project Leader provided mentoring and help to convenors from the following cross-disciplinary programs and courses:

Courses within Master in Cyber Security Program:

- ZEIT 8037 Cyber Security Risk Management – Cecil Goldstein (convenor and industry fellow);
- ZEIT 8035 Cyber Terrorism - Glenn Diesen (convenor and sessional staff)
- ZEIT 8018 Cyber Defence: Governance, Management and Acquisition – Elena Sitnikova and Keith Joiner
- ZEIT 8024 Software Security Life Cycle – Elena Sitnikova

Courses within Master in Systems Engineering Program:

- ZEIT 8231 Test and Evaluation (in all three instantiations) – Keith Joiner
- ZEIT 8230 Requirements Practice – Bronwyn Jones

Please note: ZEIT 8032 and ZEIT 8018 are also offered globally as part of PLuSAlliance initiative to ASU.

Inspired by some preliminary results from the first 6 months of the project and implementation of online forums in ZEIT 8018, the Project Leader has worked in collaboration with Keith Joiner on securing the Scientia 2018 grant, *"Towards understanding changes in classroom environment required to engage post-graduate distance students online with formal assessments"*. This grant is built upon the Project Leaders' initiative on including peer evaluations as a summative assessment and will be further investigating how students value and measure effectiveness of critique discussions and fellow student's feedback for their other scaffolded assignments.

As such, we believe that the project is widely applicable and has had high impact in other Master level online courses. However, with further research and dissemination of the approach to UNSW in Kensington, we hope to expand our ideas that may lead to another possible Scientia grant application for future customisation and implementation of this approach in other online courses in both, post-graduate and undergraduate courses.

3. Dissemination strategies and outputs

The current state of the project allows us to deliver artefacts to disseminate findings:

- Internationally:
 - A conference paper entitled *"Lessons learned: Understanding online engagement satisfaction in a large postgraduate Information Assurance Principles (IAP) course"* is published by the 29th Australasian Association of Engineering Education (AAEE) held in December 2018.
 - A journal paper with draft title: *"Fostering online student engagement: A predictive model of students results in a large postgraduate IAP course"* is submitted to Elsevier journal Computers and Education <https://www.journals.elsevier.com/computers-and-education/>
- Nationally:
 - A Connections seminar presentation hosted by UNSW Canberra and livestreamed to Kensington (12th September 2018).
 - A short presentation at the annual Teaching and Learning event in Kensington (26th of October 2018)
 - The project leader has been interviewed by Sonal Bhalla from PVC Education office via Skype. Video recordings will be used as modules for an Online Teaching course they are developing for teachers on how to engage students online

4. Evaluation of project outcomes

In this project, we developed a pilot for the IAP curriculum with a specific focus on the scaffolding of the cornerstone assignment. We aimed to maximise student' engagement with a 'new way' of learning through scaffolding and constructive alignment (Vygotsky 1978, 2002; Biggs, 2008, Biggs & Tang 2011). Student engagement has been linked by scholars to student satisfaction and student learning (Kuh *et al.* 2006). This project draws upon two interrelated definitions of student engagement for its investigations by connecting engagement with grading. Firstly, Kuh *et al.* (2006) states that student engagement is a form of participation that 'leads to a range of measurable outcomes' (p.44). Secondly, Krause and Coates (2008) have defined student engagement as 'the extent to which students are engaging in activities that higher education research has shown to be linked with high-quality learning outcomes' (p.493). In other words, the impact of online group participation upon 'critical thinking, grades, and persistence' is investigated. For example, one area of

measurement is to investigate the extent to which students have an improved understanding of key concepts of the unit at the close of the semester (Parker, p.27).

The rapid and advancement of Internet technology has changed the traditional forms of teaching and consequently the new forms of online and blending based teaching have been appeared (Wolbrink *et al*, 2014). These new systems have been armed with wikis, forums, online collaboration and other supporting logistics which their positive roles are reported in the literature (Pito-Llorente *et al*, 2018; Biasutti and el-Deghaidy, 2015). Many scholars have agreed that online discussion can help students in planning their course, deepen learning and sharpen critical assessment (Gasparic and Pecar, 2016). These new platforms also allow the students to collaborate together during the course, which has been proven to be an effective way of increasing student engagement (Soundarajan, 2013).

According to Vigotski's theory of students "readiness" to sophisticated learning through their activities in scaffold curriculum and assessment design. The concept of online engagement and scaffolding assignments (Sims, Dobbs and Hand, 2002) has already well-established by the Project Leader and documented practice with students in the Master course, Engineering Research Practice (ERP), at UniSA (Ferris *et al*, 2008, 2010) It has been proven that scaffolded curriculum and assessment, combined with discipline-specific writing support, resulted in students' higher quality work (Sitnikova Duff 2009). A series of formative assessment tasks are set in relation to (in this instance) writing the research proposal. Each task is 'nested' and one builds upon the other where students 'learn' from feedback provided and through in class workshops from their fellow students and consultations with the staff involved. While online courses have transformed distance education and are regarded by both, lecturers and administrators as being integral to any long-term growth plan for institutions, there still remains great scepticism about the quality of online units (Parker, 2015). This is something that we are certainly aware and keen to avoid by reflecting often on our teaching and learning practices.

In this project we examined the assignment's structure, analyse student grades and establish how online engagement might be different; and how we might enhance online engagement satisfaction thus achieving better student results. We've tested a hypothesis:

If a Case Study assignment designed to encourage student engagement within online group discussions is undertaken throughout the course, students will then gradually obtain better marks as the assignment progresses; leading to overall course satisfaction and improved final grades.

We used a mixed methods approach – a combination of qualitative and quantitative methods to examine factors that might influence online engagement satisfaction of an IAP cornerstone assignment – A Case Study.

Using statistical T-test we conducted experiments for 2016 and 2017 student cohorts. We compared the performance of students for Forum 1 and 2; Forum 2 and a Case Study Presentation; and the combined results for Forum 1 and 2 with the final grades. We also examined the average performance of student over the first and second forum using student final grades. We formed the following statistical hypothesis to examine whether there is a difference in the grades of students in these three assignments.

$$\text{Statistical hypothesis} = \begin{cases} H_0: \mu_{assnigt} = \mu_{assnngj} \\ H_1: \mu_{assnigt} \neq \mu_{assnngj} \end{cases} \quad (1)$$

Where *assnigi* refers to *i*th assignment, $i \in \{1, 2, 3\}$.

Year	(Iij)					
	Forum 1,2		Forum 2 and Presentation		Forum 1,2 and Final grades	
	t-value	interval	t-value	interval	t-value	interval
2016	0.694	(-0.06; 0.14)	0.708	(-0.05; 0.11)	-1.25	(-0.15; 0.03)
2017	-3.073	(-0.12, -0.02)	-0.29	(-0.052; 0.03)	-7.38	(-0.16; -0.09)

Table 1. T-test results

As the assignment has been modified from the 2016 intake to the new structure in 2017, statistical analysis has allowed us to see how effective those changes have been. Initial findings demonstrate that after revising assessment structure in 2017, students gradually improved their skills and understanding of the course material. We have tested this statement by *T-test* as reported in Table 1. In fact, in 2017, when assessment is linked to online discussion groups (ie. scaffolded), by observing how students improved their skills gradually, we guess that particular aspects of the online engagement are predictive of an overall student grade and performance.

To this end, we use students grade over the first three forums as the input of our predictive model. There is one primary reason for this improvement; students are gaining experience when they participate in these forums, and through this experience gradually improve their skills and understanding of the course material. Thus, the more experience gained, the more their grades improve. Table 1 and Figure 2 shows that both cohorts achieved higher final grades when compared to previous assignments. Results from 2017 also show that the student performance improves gradually after the new framework for course assessment is implemented, compared to 2016 where student performance decreased between Forum 1 and Case Study Presentation. However, we see poor performance in Forum 1 2017 because 5 students did not participate which is might be due to the fact the deadline for completion was at the end of the first week and assignment started in preliminary week "0" when many students were still away. This problem has been addressed for 2018 IAP.

Year	Forum 1	Forum 2	Presentation	Final grades
2016	0.74	0.71	0.67	0.78
2017	0.66	0.73	0.74	0.81

Table 1. Students results

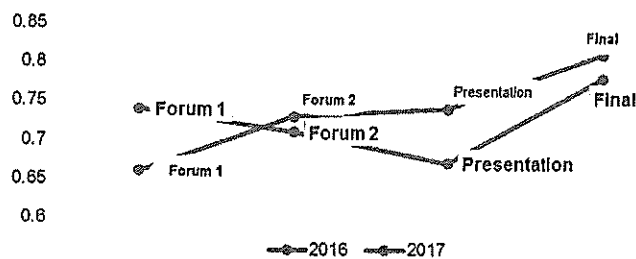


Figure.2 Student results in both, 2016 and 2017

Two different types of surveys were used to collect student opinions about their experience in an online learning environment. The first was a *mid-semester* evaluation. This evaluation allowed us to receive student feedback half way through the course. The second survey was a standard UNSW end of semester *MyExperience* survey where students were invited to provide overall feedback on the course. Both surveys were anonymous. Students rated their experience in online assignments, as well as their group engagement and the impact on their studies as well as further assignments. In both surveys open-ended questions were provided to enable students with an opportunity to suggest course improvements. The response rate in the *mid-semester* survey was higher than for the *MyExperience* survey. Anonymous surveys were coded using summative content analysis. A rich data source and feedback from both surveys was coded and quantified into categories relating specifically to student engagement, quality of discussion forum, dependence upon other students, structure of discussion forums, and instructor/marker interaction. Qualitative data from student and instructor' interviews has been collected and analysed. Together, it provides deeper insight into students' experience in online engagement and further understanding into causes that lead to student dissatisfaction.

The preliminary results were as follows:

- The need for development of cross-disciplinary teaching online framework was initiated based on the IAP 2016 student survey feedback. Approximately, 75% of all surveyed students stated that an online interaction supported them in their study and helped them engage better throughout the course. Also, 90% of students stated that digitised resources including online forums helped them in their study and 80% of students found that the feedback received from the course instructors had a positive impact on their learning process.
- In 2017, we introduced a pilot that included a new assignment structure. Students were required to demonstrate their engagement by sharing their skills and expertise with their instructor and fellow students by participation in three scaffolded assignment components: two online forums and the summary presentation. Forum 1 (preliminaries) and Forum 2 (comprised with 3 parts: Part 1 "initial" post, Part 2 "reply posts" and Part 3 "peer evaluation") (refer to Fig1.)
- Overwhelmingly, the feedback and comments on the use of forums was positive; with 74% (50/68) comments being positive. The relevance of the forums to the modern workplace, helping students

prepare for future assignments and generally improving their research skills were the most prevalent sentiments and were closely related. Enabling student interactions, particularly in the context of working and distance students, was another key theme that emerged. "...that iterative approach to the online discussions. I liked that... I'm a bit of a fan of those short engagements." [Student, focus group]

- o The most noticeable difference between 2016 and 2017 was in the data that students provided in response to the question: *Instructors' feedback help to improve future assignments*". In 2016 students were marked only by instructors, however in 2017 received feedback from their fellow students and instructors/markers. In particular, Part 3 of the assignment required students' participation in evaluating each other's work. Despite some positive feedback on peer assessment component: "*The person who was my counterpart had actually read it and thought about it a different angle to the same piece that I was talking about*", we found that students dislike being assessed by their fellow students. Only 29% of the students agree on their evaluation by their peers, while 86% prefer being evaluated by the tutor and the rest believe in self-evaluation. Moreover, 59% of surveyed students see that peer-evaluation is inaccurate measurement of their online engagement and only 16% believe in its accuracy, while the rest are neutral. Overall belief in the importance of feedback on student progress through this course considerably decreased compared to 2016 showing overall agreement of only 48% (Fig.3). Furthermore, there was some confusion on what was expected of the students when assessing their peers. "*I don't feel that I'm unqualified, which I absolutely am not qualified, but it's hard enough being a student.*" [Student, focus group]

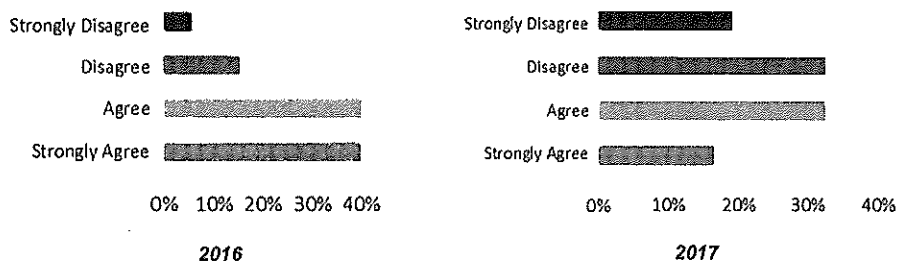


Figure.3 Question: "*Instructors' feedback help to improve future assignments*"

- o An examination of the coded qualitative material reveals that student dissatisfaction was largely due to lack of fellow student timely participation in online forums, as well as students dropping out of course prior to the census date and affecting the group dynamic. For example, 50% of coded comments relating to online learning from the mid-semester survey reflected frustration about assessment (online discussion forums) being dependent upon other fellow students. Also 92% of all surveyed students preferred a "structured assignment" that included strict deadlines for each parts of the Forum 2.

As a result of the project findings and initial data analysis, we have already implemented some changes in the revised framework for 2018 iteration of the course. We have communicated those changes to new cohort of students via Moodle. For example, previous students told us:

... we were divided into small groups of 3 [for Case Study], and as it was over census many students dropped out. In my group I was the only student remaining which meant that I had difficulty completing the task and it was detrimental to my case study preparation. [Student, semester 2 2017]

We have moved Forum 2 to Forum 3 timeslot and responded:

You will notice that Forum 3 - A Case Study Discussion is now scheduled in week 6 of the course (after the Census date) [Note from the course convenor on Moodle, semester 2 2017]

We strongly recommend to all course convenors to follow this approach and only schedule group online assignments after the Census date when implementing online discussions. In addition, machine learning predictive model, in contrast to student negative comments, demonstrates that online engagement with their fellow student has a positive impact on their final grades and a more holistic understanding of the course content.

Limitations and Future work

As planned, we have collected data from student surveys as well as interviews with students, instructors and tutors; and provided analysis using both, qualitative and quantitative methods.

Two main limitations of this project are: two iterations of the course and a small sample size of interviewed students. However, our findings are suggesting that there are more effective ways of addressing student engagement issues. The results from this pilot will also be used in combination with data from another co-authored Scientia 2018 project entitled: "*Understanding classroom environment required to engage post-graduate distance students*" where several courses are observed and ~ 300 students have participated in surveys and interviews. This future works will provide us with more deeper understanding of "student voices" achieving a better baseline for shaping a framework of online engagement as established in this pilot. Another venue for future development should be on educating academics on complexities of teaching online; as creating online group assignments requires time and assumes skills that course instructors and educational designers need to understand, develop and practice (see *Dissemination* section earlier in this report).

It is our hope that our experience will nevertheless, serve as an encouragement and support to other educators facing similar challenges.