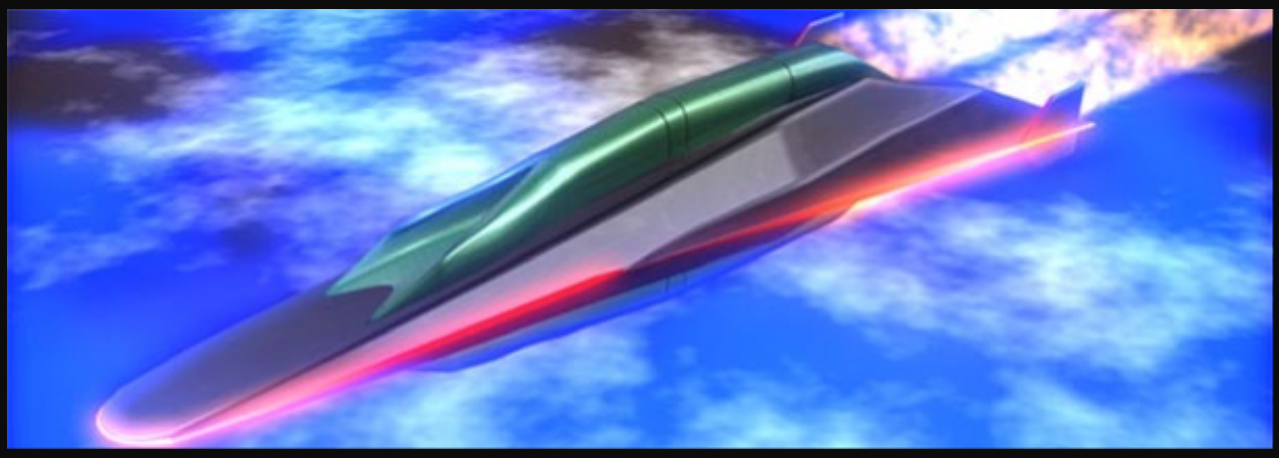

Hypersonics – from Shock Waves to Scramjets

HYPERS301x

Course Report 2014

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Introduction

'Hypersonics - from Shock Waves to Scramjets' (Hypers301x) was first offered as a UQx course in 2014. The University of Queensland has carried out research into hypersonics for many years and the team members are experts in this field. The course aims to provide an understanding of flight at speeds greater than Mach 5, and investigates how to analyse the performance of a scramjet.

The Hypers301x course was designed with two audiences in mind and therefore has two recommended pathways for students to choose. The 'advanced' (or primary) pathway is designed for students with prerequisite knowledge (listed below). For students unfamiliar with basic university engineering and mathematics, a 'beginner's' pathway was provided that gave students an overview of the fundamental concepts and principles for each section.

Course Information

Overview

Registration Open: 31 December 2013	Launch Date: 6 April 2014	Close Date: 8 June 2014
Report Generated: 30 March 2015	Course Length: 9 weeks	Course Instance: First run
Estimated Time: 45 hours in total	Languages Offered: English only	

Prerequisites

For those learners who wanted to delve into the course more deeply, it was recommended they have a good understanding of introductory concepts in Calculus, Fluid Mechanics and Thermodynamics. This knowledge would allow the learner to fully participate in the course, particularly the assessment tasks.

The following courses were recommended to learners to access before starting the course to get up to speed:

- Differential Equations (MIT OpenCourseWare): Unit 1: Basic Differential Equations, Linear Ordinary Differential Equations, Integrating Factors
- Calculus with Applications (MIT OpenCourseWare): Any calculus related math required for our course
- Thermodynamics and Kinetics (MIT OpenCourseWare): Look up lecture notes to cover basic introductory thermodynamics

Course Team

David J. Mee Richard G. Morgan	Michael Smart Vincent Wheatley	Anand Veeraragavan

Course Structure

Figure 1. Course structure.This course structure graphic highlights the course components in the order that they appear in the course. (This graphic is adapted from the MITx Course Reports.)

Unique Structures

The summative assessment throughout this course culminated in a final project in which each student was given an individual set of flight conditions and scramjet design specifications. They used these to analyse their own scramjet engine. The final calculation was an overall engine efficiency for their engine. Each student then added his or her point to a plot of engine efficiency as a function of flight Mach number. As students completed the project, an overall map of engine efficiency versus flight Mach number was built up for a series of engine designs. This allowed the class as a whole to build a classic plot that shows how scramjet engines perform in flight.

Learning Objectives

1. Understand when compressible flow occurs, how a compressible flow behaves and when a flow becomes hypersonic
    a. calculate speed of sound and Mach number
    b. calculate stagnation and static properties of a gas

2. Model 1D compressible flows with
    a. area change
    b. heat addition
    c. friction

3. Understand the nature of shock waves
    a. calculate shock angles and the change in flow properties across shock waves

4. Understand the effects on a flow when the flow is hypersonic
    a. change in thermochemistry
    b. Mach number independence
    c. Hypersonic equivalence principle

5. Understand how scramjet propulsion fits within the context of aerospace propulsion

6. Model the performance of a simple 2D scramjet engine

Other uses of the course

Several modules in this course are being used at UQ to support an on-campus course, MECH3410 Fluid Mechanics.

Course Demographics

Total Registrations

6698 students as at course close date: 8th June 2014

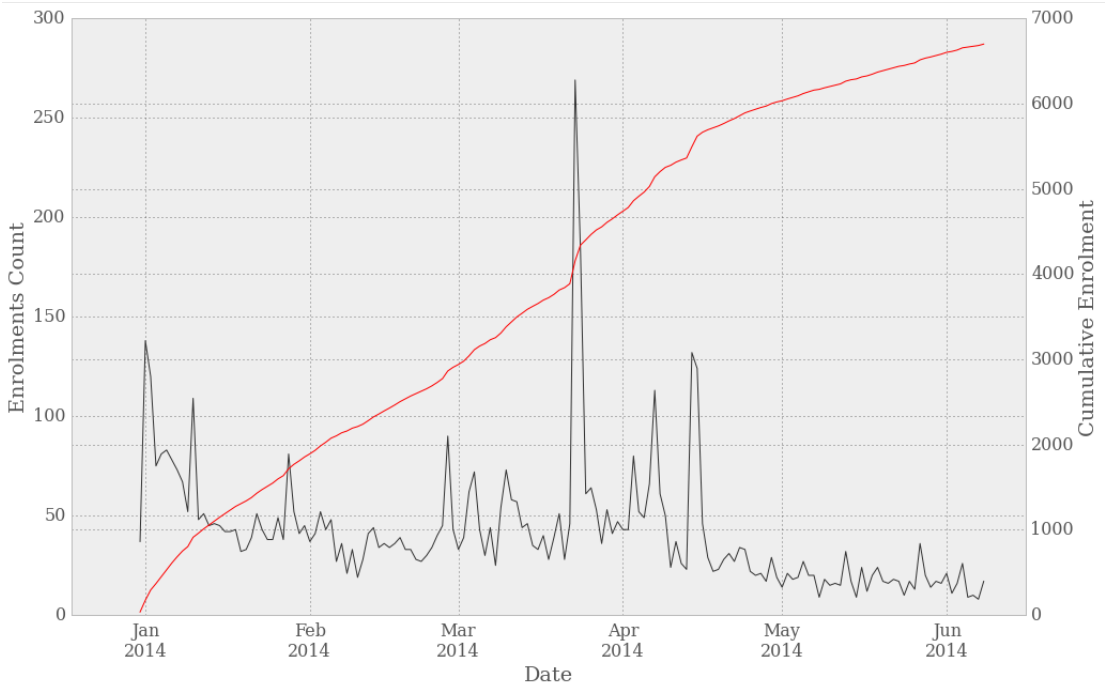

Figure 2. Registrations.

UQx Course Registration Comparison

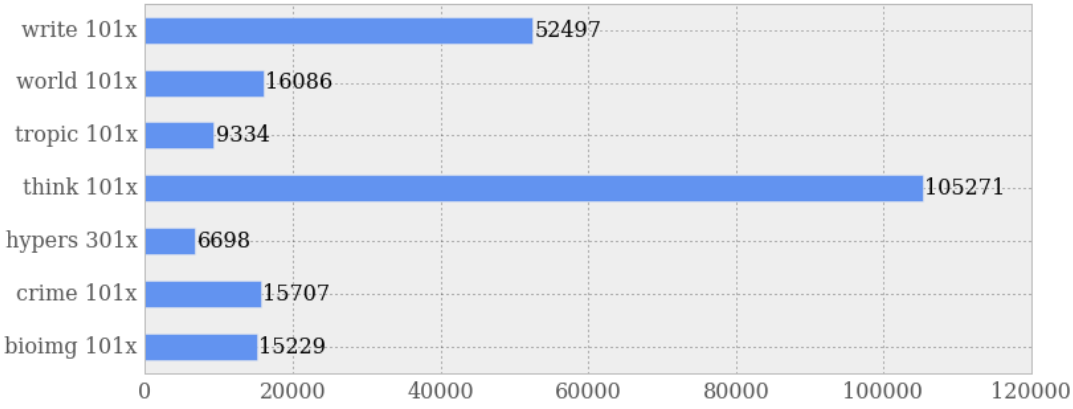

Figure 3. Registration Comparison. at respective course closing dates

Enrolment Types

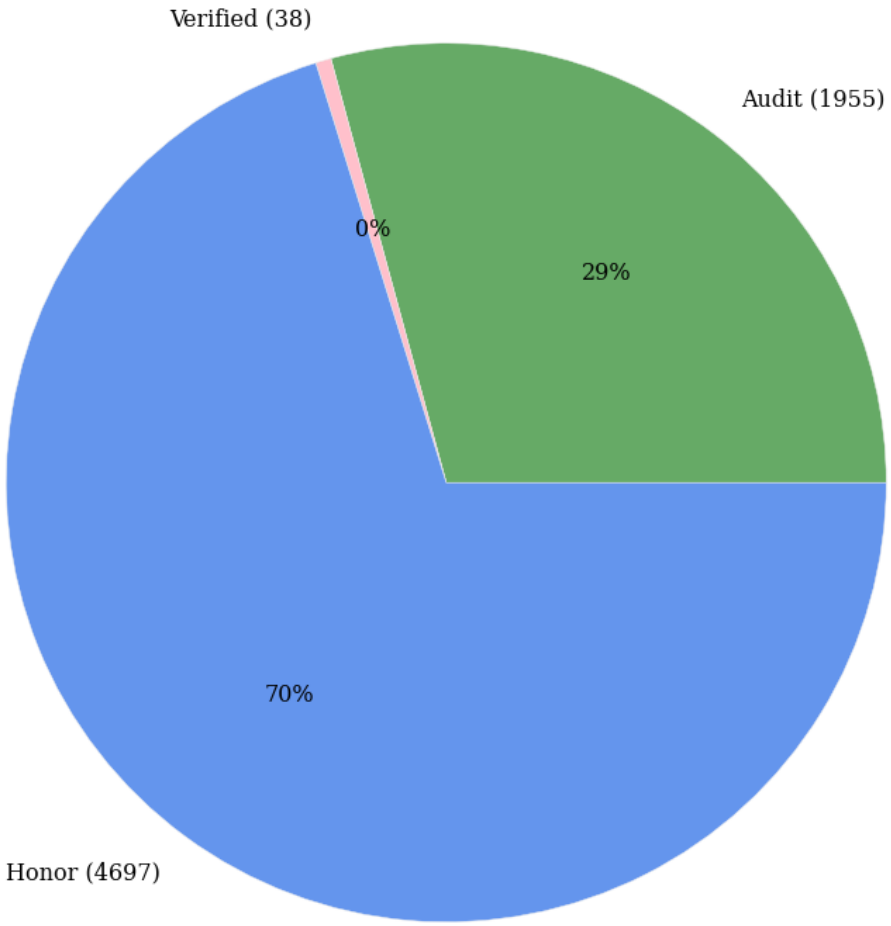

Figure 4. Enrolment Types. Two types of enrolment pathways (and associated certificates) are offered through edX. These are honor certificates (which are free and awarded if the student passes assessment), and verified certificates (there is cost associated with verifying that the student is who they say they are). Only honor certificates were offered in this course.

Student Demographics

Gender Distribution

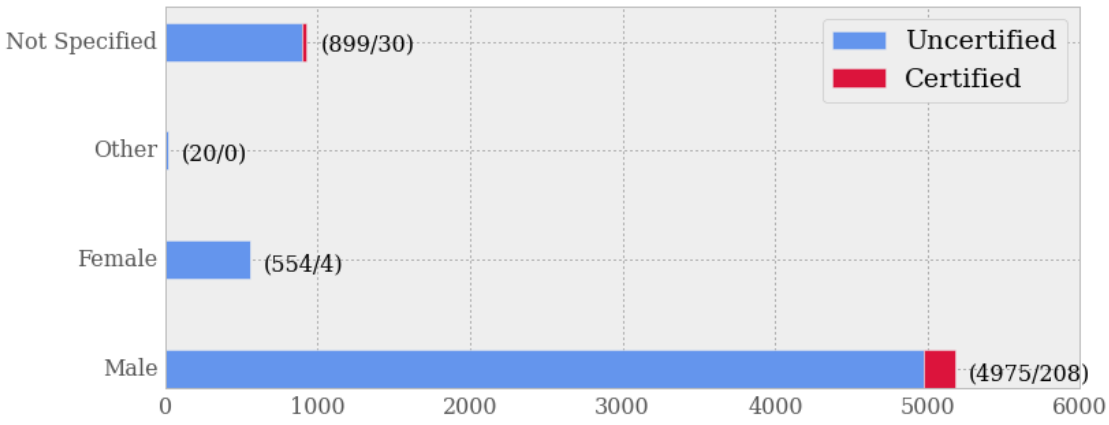

Figure 5. Gender Distribution. Certified students are students who earned a certificate.

Age Distribution

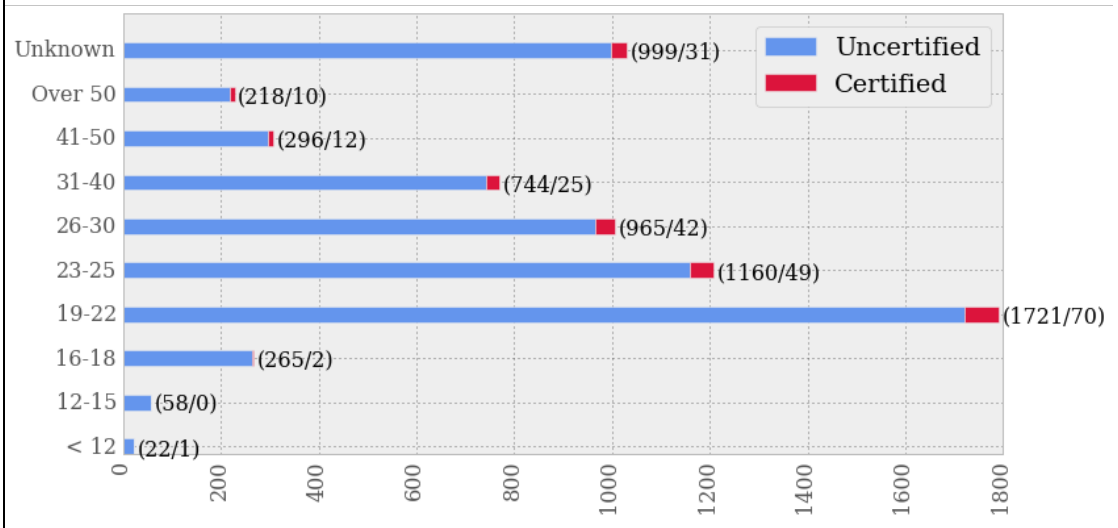

Figure 6. Age Distribution.

Education Distribution

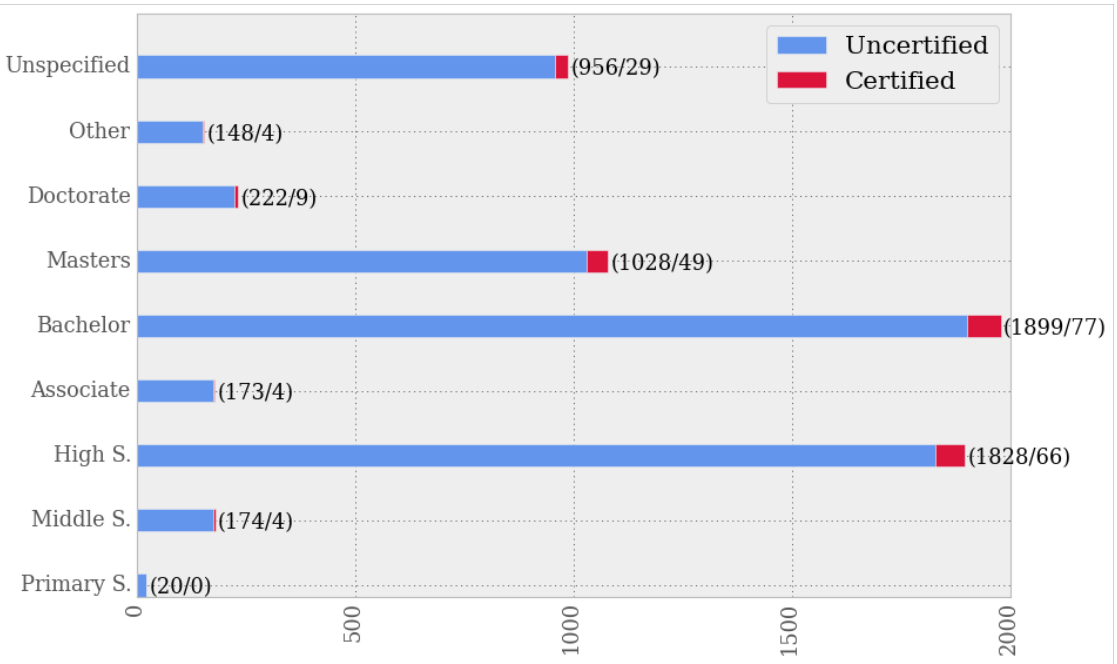

Figure 7. Education Distribution.

Country Distribution

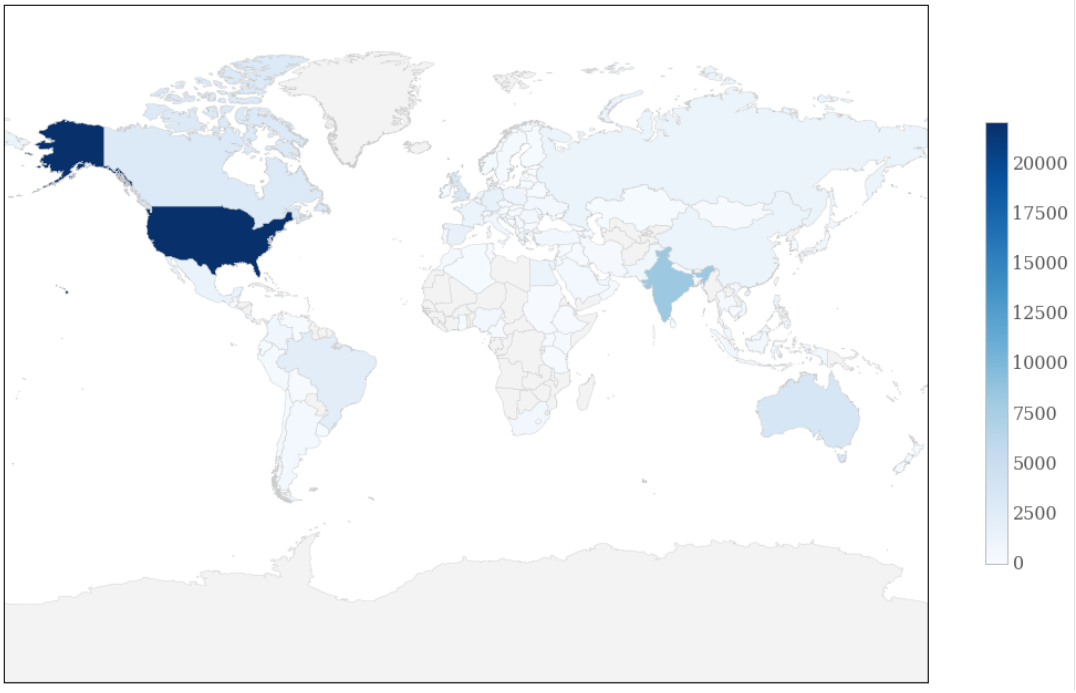

Figure 8. Country Distribution (per enrolment). 129 countries with registered users

India (1,576 registrations)	Spain (215 registrations)	Pakistan (123 registrations)
United States (1,206 registrations)	Canada (178 registrations)	Egypt (110 registrations)
Australia (256 registrations)	Brazil (174 registrations)	
United Kingdom (234 registrations)	Germany (132 registrations)	

Course Activity

Student Progress and Certificates

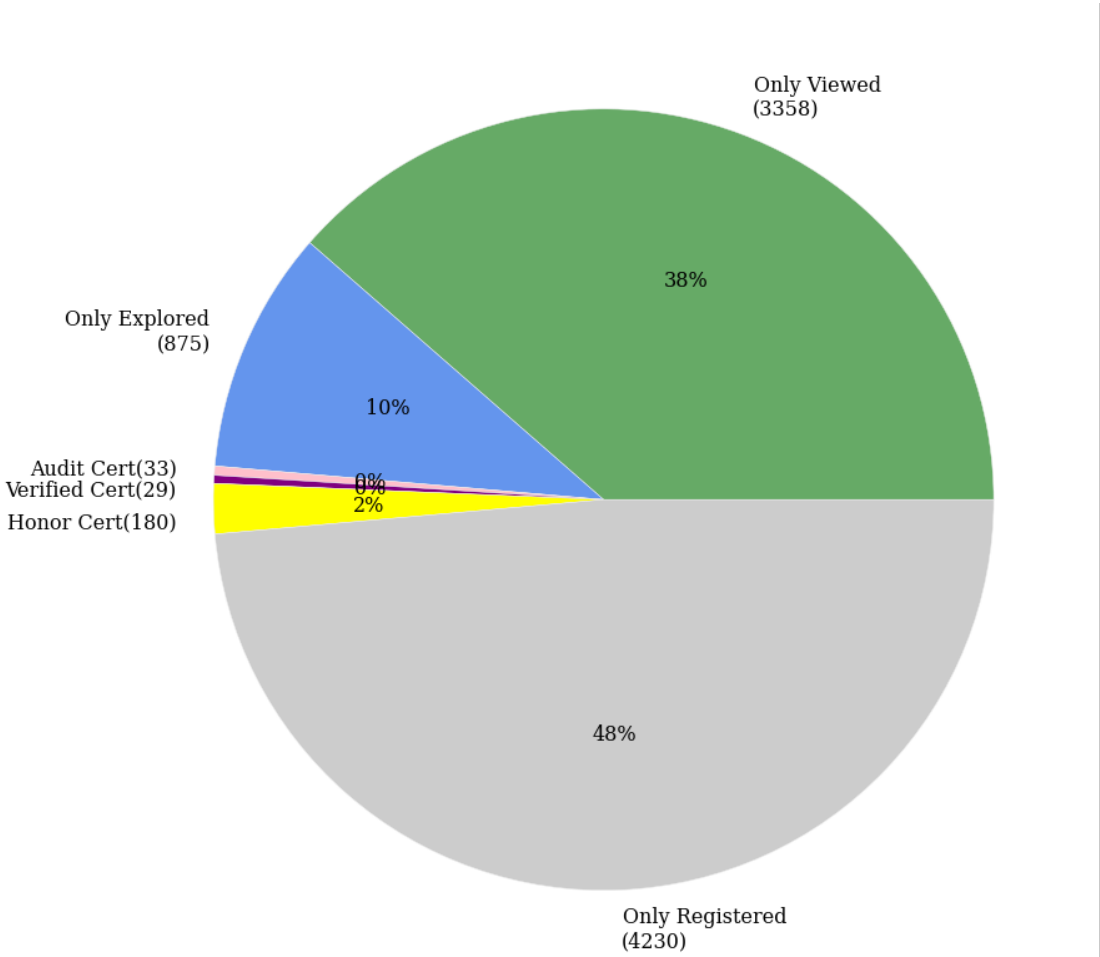

Figure 9. Student Progress and Certificates.

Registered: Registered for course but did not visit the course to access any course content.
Viewed: Anyone who accessed the 'Courseware' tab (the home of the videos, problem sets, and assessment) within the edX platform for the course. Note that there exist course materials outside of the 'Courseware' tab, such as the Syllabus or the Discussion forums.
Explored: Anyone who accessed at least half of the chapters in the courseware (chapters are the highest level on the "courseware" menu housing course content).
Certified: Anyone who earned a certificate.

Active Days

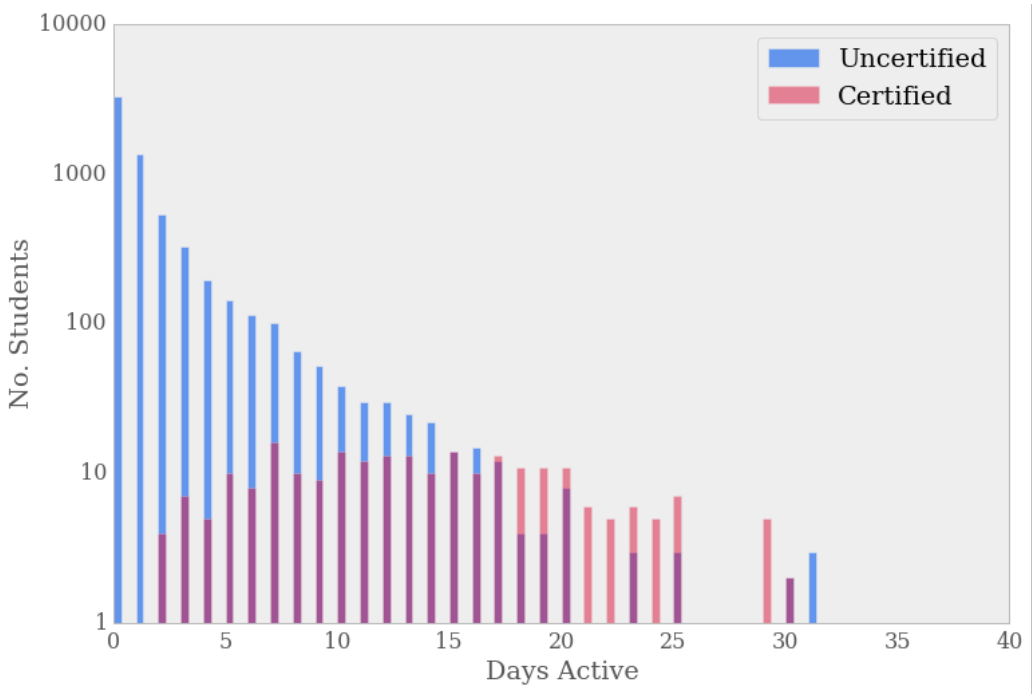

Figure 10. Activity over days. An 'active day' is one on which a student accessed the course.

Course Engagement

	REGISTERED	VIEWED ANY SECTIONS	VIEWED > 3 SECTIONS	VIEWED > 50% SECTIONS	RECEIVED CERTIFICATE
Student Count	8705	4443	1394	1039	242
% registered students	100%	51%	16%	12%	3%
% of previous column	N/A	51%	31%	75%	23%

Figure 11. Percentages of students engaged at critical periods within the course.
Taken from UQx Dashboard on February 18 2014 at http://dashboard.uqx.uq.edu.au/#/dashboard. UQ staff login required.

Last Activity Over Days

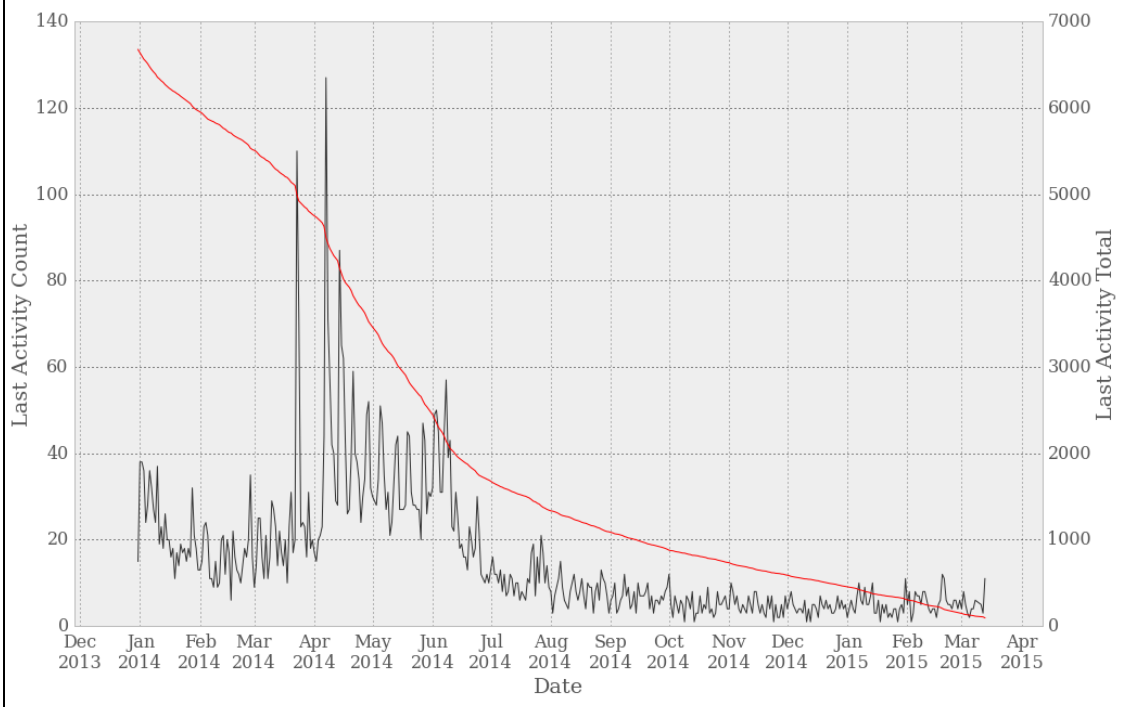

Figure 12. Last activity over days. This graph represents the last interaction with the course by each student. The black line represents the number of students whose last event was on that day (Left Y axis) and the red line represents the number of total students who were still interacting with the course on that day (Right Y axis).

Interesting Activity Patterns

One of the students in this course created a summary of each section of the course and posted the link to this in the course.

Special Aspects of the Course

UQx and the course team created the summative assessment grapher specifically for the course.

Discussion Posts Evaluation

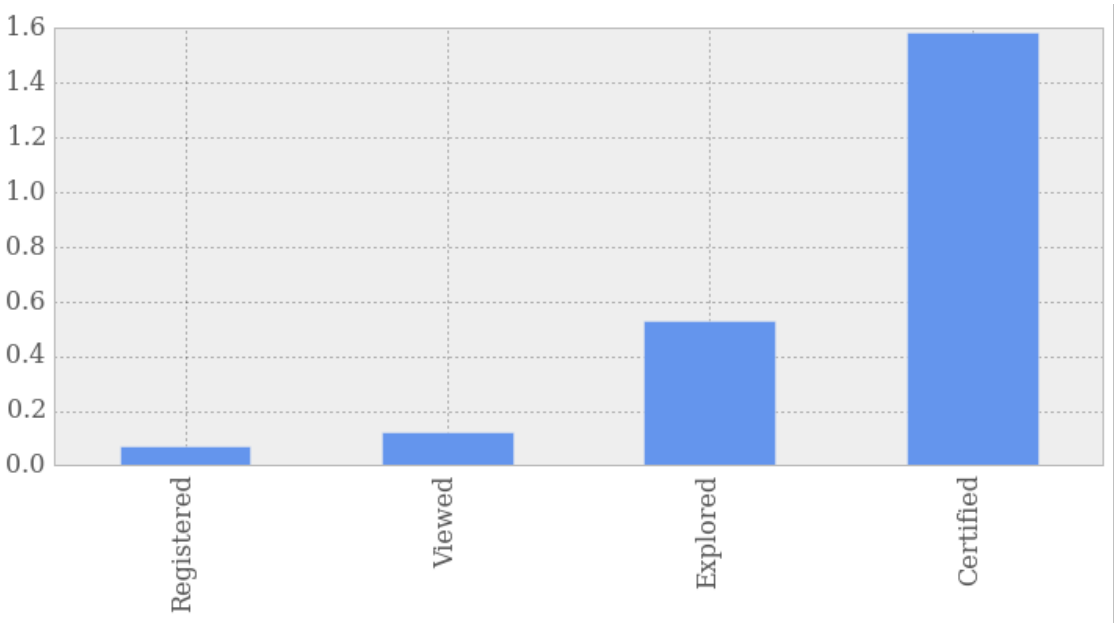

Figure 13. Discussion posts per enrolment type.

Course Evaluation Findings

In the course evaluation, students who reported that they “felt the course entirely met the stated learning goals” ranged from 49% - 89% for the six learning goals. 87% thought the course was ’appropriately challenging’ (as opposed to ’too easy’ or ’too hard’). Comments regarding what students liked best/liked least were obtained and used to update the following version.

Plans for the Future

The Hypers301x course has been released as a self-paced course in 2015.