

A combination of industry collaboration and flipped classroom to increase learners' confidence and skillset.

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Abstract

This paper discusses a new 15-credit module on Data Analytics taught at the University of Greenwich to level 6 students in the Department of Mathematical Sciences. The module was designed with significant input from industry which is documented here.

The paper starts by explaining the motivation behind the module from both the employer's and the University's perspective. It then discusses the reasoning behind the way in which the material is presented to students and ends with a summary of the results and student feedback.

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1. Background

The University of Greenwich has a mix of mature students and school leavers among its 20,000 on-campus student body, with 39% over the age of 24. Over half the student body is classified as non-white. The Department of Mathematical Sciences is within the Faculty of Architecture, Computing and Humanities and is based at the Old Royal Naval College in Greenwich, south-east London. The Department currently has around 300 undergraduate students.

In the last three to four years there has been a strong steer from University Senior Management for Departments to implement activities and module content designed to improve and enhance the University's Graduate Employment Outcomes as measured by the Destination of Leavers of Higher Education Survey (DLHE). In order to accomplish this the Department has introduced many innovations such as "Maths Graduates: Where are they now?" (Bradshaw, 2012); the IMA Business Game (Bradshaw, 2013); an employer-endorsed assignment (Bradshaw, 2014); mock-interviews with employer involvement (Ramesh et al., 2015) and the promotion of credit-bearing work-based learning placements as well as encouraging the usual sandwich placements (Ramesh et al., 2013).

1.1. Employer's motivation

In common with most companies, analytics roles are becoming more numerous and important at GlaxoSmithKline (GSK). Within Human Resources (HR), GSK has a reporting and analytics function that is responsible for the provision of management information and analytical insights on its 105,000 employee workforce whom work in over 130 different countries. For many years now Industrial Placement (IP) students have been a critical component of the team. The roles are incredibly beneficial to both the company and the students alike as the

students quickly acquire the skills needed to perform the role and become integral members of the team.

When recruiting for these roles, experience suggests that the more successful candidates have some general work experience and are better than merely proficient in Microsoft Excel. Being able to demonstrate higher levels of Excel skills in the interview is a good indicator that the applicant has experience in analysing large data sets and the capabilities required to be able to work independently and acquire for themselves the other technical skills required to perform the role in GSK. Therefore the interview includes an Excel test that the majority of shortlisted students interviewed fail emphatically even when they profess to having excellent advanced Excel skills in their applications.

Over recent years, GSK has hired many Greenwich University students into HR Analytics Industrial Placement (IP) roles and onto project teams such as data migration analysts. This has led to a partnership involving a GSK representative attending year-end celebrations and using the GSK Volunteering Day (part of the Corporate Social Responsibility (CSR) policy) to run some Excel master classes in the computer labs for second and third year students with input from IP students and other staff. This year our relationship progressed to helping design and deliver this Data Analytics module that was designed to provide the skills required to be credible in interviews and to perform the introductory tasks in analytical/data orientated roles in business, namely; Excel, SQL to interrogate databases, VBA and use of business intelligence systems to prepare dashboards and visualisations in order that more students may have the skills that are important to being viable as a data/business analyst.

1.2. University's motivation

Staff at the University noted that whenever graduates came to talk to students, regardless of their company role or the sector they were working in, they always talked about how important coding was. For some this was SQL whilst for others this was Python or VBA. All the graduates said how they wished they had done more coding on their degree programme and yet acknowledged that at the time they had not enjoyed the Matlab programming that they had covered and would have been loath to cover more.

1.3. New Module

Having talked to both employers and graduates, the Department of Mathematical Sciences concluded that it could do more to equip students for the graduate job market in terms of their skill set but also their autonomy and confidence. It was decided to instigate a new optional module broadly based on data analytics which was becoming a popular employment route for students and which focused on the skills required by GSK and other employers whilst encouraging students to self-learn much of the material.

2. Module content and teaching methods

A day was set aside at GSK for the authors to get together with several recent graduates employed by their HR Analytics Department to discuss the module content.

The graduates at GSK agreed that the module should include Advanced Excel Skills, VBA, SQL and Data Visualisation techniques utilising software like QlikView or Tableau. Discussing this with the recent graduates was very helpful as they understood the restrictions of University systems and the basic structure of a 15-credit University module. Various teaching methods were examined and suggestions proposed for assessments.

The graduates were unanimous that one of the main skills students needed was the ability to be autonomous in the workplace and so to understand how to self-learn. They also required

confidence about their ability to do a job in order to be successful in the job application process.

The module leader was already interested in the flipped classroom teaching methodology (Jungic et al., 2015) and was eager to use this in the teaching of new material. Knowing that students learn programming skills best by practice rather than listening to instruction, it seemed appropriate to harness a teaching method that encouraged active self-study rather than passive lecture attendance.

The module leader was also aware of the benefits of Inquiry-Based Learning (Kogan and Laursen, 2014) and was keen to see students develop an increased sense of ownership of their studies resulting in an increase in their self-confidence.

2.1. Assessments

It was decided early on that the module should be assessed by coursework as it is problematic to assess programming skills by examination.

There were two assignments. The first (worth 60% of the overall mark) tested the students' knowledge and understanding of advanced Excel skills, VBA and also asked for critical reflection on various aspects of data analysis in general.

The second required students to create a poster containing data visualisations created with Tableau to present a story to senior management and also included aspects of data mining and data protection. GSK offered a prize for the three best posters consisting of a day at GSK to find out more about the company and about careers in analytics in general.

Several employers from other companies have since commented that taking a large quantity of data and extracting relevant information from it to tell a story is an activity that is often used in assessment centres for graduate jobs.

3. Lecture Structure

To encourage students in their self-study the module was designed in such a way that every week the students were encouraged to complete a 'before-lecture task' and watch a short (5 minute) 'before-lecture video' on something connected to the week's topic. This included videos on debugging code, recording (as opposed to writing) a Macro and creating a dashboard in Tableau. These were all activities that were not covered in class but that students were expected to be familiar with before the class by watching the video and doing the activity. This started in the very first week.

The class was timetabled to start with a two-hour lecture at 9am on a Friday morning followed by an hour's break and then an hour's session in a computer lab. This was not ideal but was the way that the timetable had been prepared and so was a given constraint.

Half of the first 'lecture' was spent explaining the motivation for the module and detailing how it would be run. This was designed to excite those who wanted this sort of experience but to put off any students who had chosen the module purely because it was coursework only or because their friends were taking it.

The lab session in the first week consisted of an exercise in Excel to teach basic data editing and manipulating using Excel formulae such as 'trim' 'right' 'mid' etc. The exercise caused so much interest and excitement that neither staff nor students were aware of the time and the class lasted for 15 minutes more than it should have done. This became a recurrent theme in the early lab sessions.

During the term three speakers from industry came to talk to the students during class time. These were Ben Nicholas (GSK) on the motivation behind his involvement in the course, Katherine Brewster (FDM) on how to apply for jobs in data analytics and the benefits of graduate training programmes, and Amir Khan (RBS) on the role of a data analyst. Out of these some other impromptu sessions arose such as interview skills training with RBS and a video interview workshop with FDM.

In the other classes, technical material was not taught as such but merely referred to. For example the explicit syntax of a loop in VBA was not taught but the concept of a loop was explained and discussed with the class as a whole.

Each week students had a very short recap session on the previous week using personal response systems to test their understanding. Some questions were designed to be humorous whilst others enabled the lecturer to see if the students had understood the previous week's content and also provided formative assessment for students on their own understanding. There were also group activities and discussions around data.

In general the classes went well although some finished a little early due to the group activities not lasting as long as had been expected. This is something that will be rectified next year.

4. Results

Initial feedback was very positive. The students were asked to provide their initial thoughts after the first week via the University VLE and 17 chose to do so – this is from students who had previously always refused to participate in similar requests for feedback. There was an overwhelmingly positive response, although a couple of students did express slight concern as to whether they were up to the rigor of self-study. Examples of this feedback can be seen in Table 1.

Table 1 Examples of student feedback on the new module gathered after the first teaching week and then at the end of the module.

Quote	Week
A very interesting course, with lots of new things to learn about. Though it is not meant to be easy, it is a challenge which I am keen to deal with.	1 st week
At first, during the lecture, I was unsure. Even when the lecture ended I was slightly on edge. However, after having completed the tutorial which was tough but enjoyable. I feel like I know I should be doing this course.	1 st week
Seems like a challenge, will push me to work harder as methods aren't always there to refer to. Like the idea of having to self-teach some content, more likely to stick in my brain this way.	1 st week
Employers made me realise how important Excel is.	Final week
Helped me decide what I want to do and pushed me to start applying for jobs.	Final week
I now know I am able to learn new things on my own.	Final week
Have become more confident.	Final week
I am now a step ahead of where I would have been if I hadn't taken this course.	Final week
The course encouraged me to think logically and pay attention to detail	Final week
The videos were a great way to introduce lecture material and useful resource for coursework.	Final week

An informal paper-based survey of students was completed at the end of term. It should be noted that this was only issued to the students who attended on the final week which was a

self-selecting sample and likely to be the most enthusiastic. However the comments they made (see Table 1) are particularly encouraging and representative of comments that students had been heard making throughout the course.

Initially the students engaged well with the 'before lecture tasks and videos'. However after the first coursework was released there was a significant drop in the number of students accessing the files. This was disappointing as the second assignment was based on the later material. However from the statistics presented in Table 2 it seems that many of the videos were accessed after the teaching of the course was completed, showing that numerous students decided not to engage with the material until they had to actually complete the second assignment. Interestingly at the time of writing this paper it was noticed that some students had accessed the files after all assessments had been completed presumably for preparation for job applications and interviews.

Table 2 Percentage of students who completed various activities before or after class.

Main topic each week	Percentage of students undertaking particular activities			
	Before class activity completed BEFORE class	Before class activity completed AFTER class	Watched video BEFORE class	Watched video AFTER class
Advanced Excel	80.7	95.5	68.2	85.2
Lookup	71.6	89.8	67.0	93.2
Pivot	69.3	85.2	72.7	96.6
VBA1	72.7	85.2	71.6	98.9
VBA2 - Loops	53.4	68.2	44.3	73.9
VBA3 - User form	55.7	68.2	44.3	83.0
SQL/LinkedIn	36.4	62.5	10.2	26.1
SQL	31.8	51.1	31.8	59.1
Data protection	31.8	53.4	21.6	52.3
Data mining	17.0	37.5	18.2	62.5
Tableau 1	21.6	42.0	25.0	76.1
Tableau 2	13.6	28.4	13.6	45.5

5. Conclusions and future work

The module has been very popular with students and final year students employed as ambassadors have been overheard talking positively about it to prospective students at open days and applicant taster events. Anecdotally there appears to be more of this year's cohort obtaining jobs within data analytics and being interested in this as a career. Also the number of students applying and obtaining places on Master's programmes in data science has increased enormously. What is particularly pleasing is that student feedback implies that this has helped increase confidence and their ability to be more proactive learners and indeed in the 2016 National Student Survey 91% of this cohort (BSc Mathematics) said that their degree had helped them present themselves with confidence putting Greenwich in joint second place for this question.

Input from other companies has been forthcoming with many employers endorsing the mindsets and skills that are being taught. One employer in particular is producing a series of case studies that can be used for small group work during the 'lecture' time. These are themed to fit in with the topics that the students will be focusing on and will encourage students to think through relevant real-world problems that they will not have come across before.

The initial overall evidence of the module's content and delivery style indicates this is delivering benefits across the spectrum. Potential employers have had the opportunity to input into academia the type of skills required in the ever-growing analytics domain and equally importantly building the ability of employees entering the workforce to self-teach and research the skillsets they need to build. At the same time the University of Greenwich is delivering a new popular module that meets industry's needs and enhances the marketability of their students.

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