How to maintain the conversation, group work and peer assessment when a modest post-graduate course goes big

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STRUCTURED ABSTRACT

CONTEXT
This paper reviews some of the on-line teaching innovations undertaken to enhance the student experience in a post-graduate engineering course as student enrolment numbers have soared. The course focuses on emerging challenges in electricity industry planning and economics – challenges that raise numerous open questions and don't yet have agreed answers. Until recently, class sizes were small enough to facilitate an open conversational teaching approach with lots of discussion and tailored to the particular interests of the student cohort, a major group work component and peer assessment. In the past five years however, class numbers have grown more than five-fold, causing increasing difficulties for this inclusive and collaborative teaching approach. Over the same time, there has been major progress in on-line teaching tools and methods, raising the question of whether these innovations might allow us to maintain the conversation, group work and peer assessment on which the course was built, despite these greater student numbers.

PURPOSE
This paper presents some key insights we gained in testing a range of on-line innovations to the running of this postgraduate course in 2018 when, for the first time, we had over 300 students. The focus of these innovations was to continue, as best possible, the conversation between students and the lecturers that has been a feature of the course since its original inception over two decades ago, and support group work with associated peer assessment despite having over 60 groups to manage.

APPROACH
We extended the universities online learning tool to include an online set of initial student surveys, in class quizzes and project wikis that were all intended to encourage students to actively participate in what is a very large post-graduate class. The usefulness of the surveys and quizzes as well as the group project workflow is assessed, and the students' activities in the online learning platform and its correlation to students overall assessment outcomes was evaluated.

RESULTS
We saw high student participation in the voluntary initial surveys and in-class quizzes. The surveys assisted in setting the course content, while the quizzes were very helpful in testing students' understanding of particular concepts, as well as their views on some particularly challenging and open questions on the future of the electricity industry. The project wikis proved highly successful in allowing students to present their own group work in a variety of ways, and engage with the group work of others. The on-line peer assessment automated what had been previously a fairly onerous task of determining group project marks.

CONCLUSIONS
This paper describes our efforts to use on-line tools to continue the conversation, support group work and associated peer assessment as a postgraduate course on electricity industry planning and economics grew in numbers from typically around 50 students to over 300 in around five years. While there are certainly limits to what such on-line innovations can do to make large classes appear small to the students, they do appear to have contributed to student satisfaction and learning.

KEYWORDS
Big class, students' engagement, In-class activities

Introduction

This paper presents our experience in implementing a set of on-line tools and approaches to maintain the conversation, facilitate group work and support peer assessment in a post-graduate course that has seen very significant growth in student numbers over the past five years. The course deals with electricity industry planning and economics from a range of engineering, economic, commercial and governance perspectives. This area is changing rapidly with growing concerns about the environmental impacts of the industry, new technologies including renewable generation sources, a move towards more market-based arrangements, and the emergence of engaged energy consumers – now termed prosumers who are looking to play a greater role in their electricity provision. Over the 25 years that the course has run, these changes, and the many questions that they raise for electricity industry planning and economics, have been addressed through a highly conversational teaching approach with lots of class discussion, and group activities including peer assessment. This discussion has been used to ascertain the knowledge, skills and particular interests of the students, ensure that they understand key concepts, and debate some of important open questions of the future electricity industry. The group work allowed students to undertake relatively ambitious applied research projects on particular areas of interest within the broad area of electricity industry planning and economics. These were then presented to the entire class giving students the opportunity to effectively develop course content for their class peers and assess each other's contributions.

Unfortunately, this teaching approach has become less tenable in recent years due to rapidly growing numbers – from typically around 50 students to 100 then around 200 then over 300 in around five years. The course last year proved particularly problematic with around 200 students and formed the motivation to try a range of on-line teaching activities and tools for the course this year when, as it turned out, student numbers climbed to over 300. This paper presents some examples of the steps taken in this regard, and their impact on the class conversation group work and peer assessment. We believe some of the techniques and their outcomes may be of interest to other engineering educators, especially in applied postgraduate courses with growing student numbers.

Approach

These efforts included establishing forums for the class discussions to continue outside of formal class teaching periods. For a range of reasons, students generally don't attend all lectures. Even when they do, many have some challenges with language comprehension. This is a particular challenge at present for many of our postgraduate courses with a high number of non-native English speaker students which can have impact on their learning and engagement, but which can be addressed, at least in part, through educational aids such as capture recording (Leadbeater, et al, 2013). For a number of years, UNSW Engineering Courses, including this one, have generally provided on-line recordings of all the lectures. The UNSW's online learning management system has highlighted the key role of these lecture recordings with a substantial number, often the majority of the students viewing the lecture video of the class to supplement their learning. One desire, therefore, was to better support class discussions outside the formal lecture times.

Another key objective was to ensure we understood the students' existing knowledge and skill base in order to determine if particular preliminary materials needed to be provided, or additional skills development. Beyond this, we wanted to ascertain students' particular interests in order to tailor the course content to ensure these received at least some attention. We used initial course surveying for this. The results helped us to design the most effective course outline as the student's background and their perception can have a significant impact on their learning and engagement in class, as highlighted in previous studies (Philips, et al, 2017).

In engineering studies, team work plays an important role in developing required skills for students' future career. The ability to work effectively in a team together with communication and creative thinking are listed among the highest factors needed for the STEM graduate employability (European Commission, 2015) highlighting the importance of group project as a platform for practicing engineering team work. Group projects have always been an important part of this course. As class sizes grow, however, it became increasingly challenging to effectively manage all the group work and students communications, and track and assess students contributions. We therefore wished to explore on-line ways to facilitate the process. In addition, recent studies have highlighted the importance of innovative problem-based and query-based classroom to enhance the learning process (Warter-Perez, 2012 and Hall, 2002). Again, we wanted to explore ways to quiz the students during lectures to test their understanding of particular concepts, but also their opinions on open questions.

The rest of the paper details our efforts in all these areas, and offers some preliminary insights on how well these approaches assisted in maintaining the conversation, facilitating group work and its contribution to the overall course content, and supporting peer assessment.

Findings

Establishing the Students' background experience and skills

Due to the very broad scope of this course, it is important to find the right pitch in exploring different related topics. A demographic survey was therefore conducted before the first lecture to explore the students background, educational experience, and previous knowledge around a wide range of potential topics. Previously this had been done through early discussions in the lectures that drew this information informally from the students. A different approach was now required, and we used on-line surveying that was made available before the course had even formally commenced. Figure 1 shows the distribution of nationalities, as well as their previous educational/industry experience and a self-assessment of skills.

These findings highlighted the varied background and skill level of students and hence opportunities for better tailoring the course based on different students' backgrounds and needs. Over 75% of the students were from a specific country (China), hence we ensured that we covered some context from the Chinese electricity industry. The presence of some students' with more advanced power systems education and even industry experience highlighted the challenges of ensuring appropriate levels of content – we therefore provided a range of preparatory materials while also seeking to have students input into discussions based on their experience. The level of skills which were required for this course was also varied among students; for example, only 30% of the students had previous experience with developing excel spreadsheets for automatic calculation, which is needed for doing the assignments. Only a minority had previously done a technical research oriented report and associated seminar. In response, we provided skill-based materials and specific sessions on the use of tools.

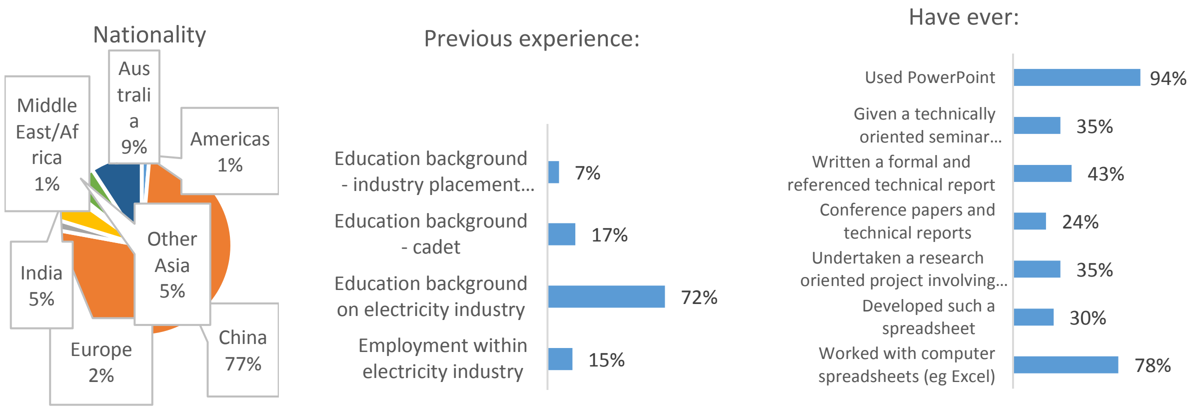


Figure 1: Some student demographics highlighting their varied background, experience and skills

Assessing Students' knowledge of the topic, and particular interests

In this course it was assumed that each student has a basic knowledge of power systems, and the electricity industry in general. But in order to explore this presumption and tailor the course based on the students' interest, another on-line survey was conducted to check the students experience and interest in different potential topics in this course. As figure 2 shows, the level of students' familiarities with different topics were wide-ranging. The students were also asked about what they like to be discussed in class and also how much they are familiar with that topic. This assisted us to have a sense to where to focus attention within the boundaries of what can be seen as key aspects of the topic. Interestingly a good correlation was observed between the "previous familiarities" and their "interest" on the topics with, however, some interesting exceptions, such as "Coal generation" which showed the lowest level of "interest to experience ratio" as opposed to PV (solar photovoltaic generation) with the highest level. This didn't mean that we removed coal-fired generation from the course materials – instead we used this insight to emphasise why the students should be interested to know more about this technology – it is after all, the most common generation technology in the world. In our view, the on-line surveying was much more useful than the previous approach of using early discussions in the lectures to establish this knowledge and interest. The students were also very interested to see these survey outcomes.

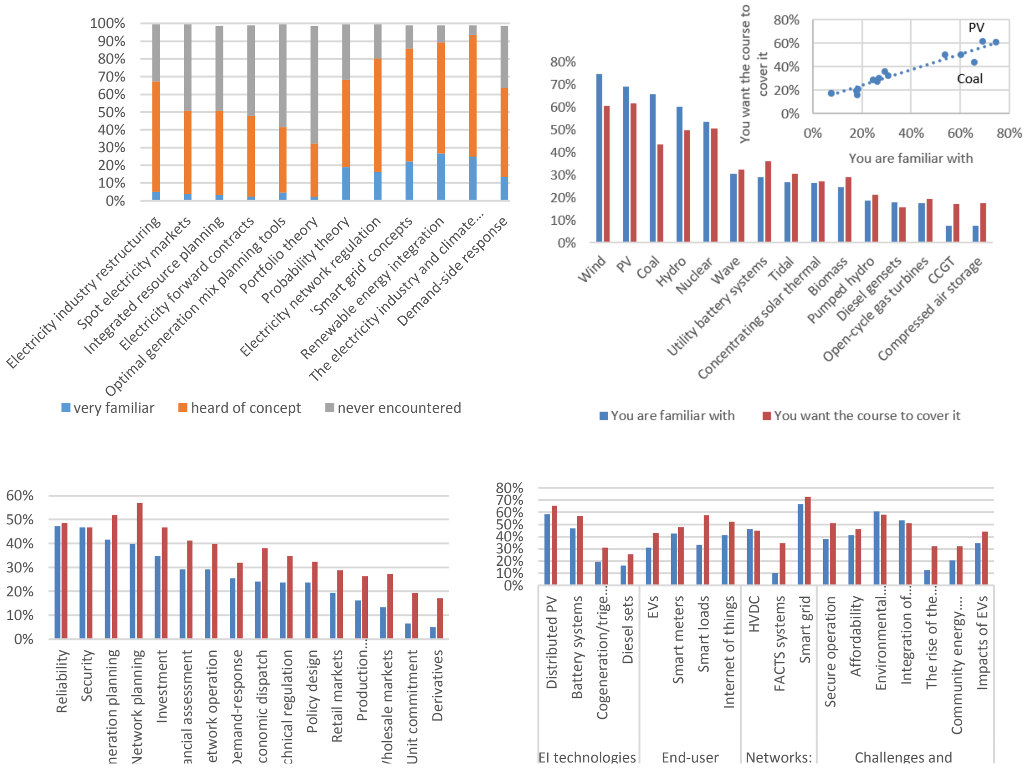


Figure 2: Students experience/interest and the correlation between those

Establishing an open inquiring student approach

Students are usually found to have some misconceptions about the field. Discussing some of the most important ones before starting the course would encourage them to think more carefully and critically about the topics. In this regard a preliminary quiz was designed with some challenging questions to survey and identify some of the preconceptions. Usually the answers to these questions are either complicated, or for the most interesting questions 'it depends'. The design of this survey was inspired by a TED talk by Hans Rosling and his quiz to medical students on child mortality (Rosling 2007). The key role of the quiz is to make sure students realise that the course will cover lots of areas of complexity without certain answers. This is not something they always come across in engineering study. The questions were carefully chosen and managed to get a majority of the students to fail strictly on analysis and was followed by an interesting discussion of how they collectively did worse than random.

Figure 3 shows the questions and students response. The results were discussed in class with the students with some explanation about the "better" answer, and in some cases on why both choices could be correct from different view points. Some of the preconceptions such as Q4 was intriguing for the students – for this particular question, the answer hinges on whether you count large-scale hydro as renewable generation or not; a rather controversial question as it happens for stakeholders. This made it clear for the students the need for revisiting the knowledge in some areas where they thought they knew the "obvious" answers, and hopefully also helped them appreciate that many of the key questions in the area of study didn't have clear answers.

Online in-class quizzes

Numerous quizzes were designed and run in class to test the knowledge/opinion of the students throughout the semester. The average response rate of 67% was achieved over total 33 quizzes. The response rate was varied from 45% (week after mid semester break) to 85% (second week). Some of the quizzes were designed to trigger the thinking about a new concept.

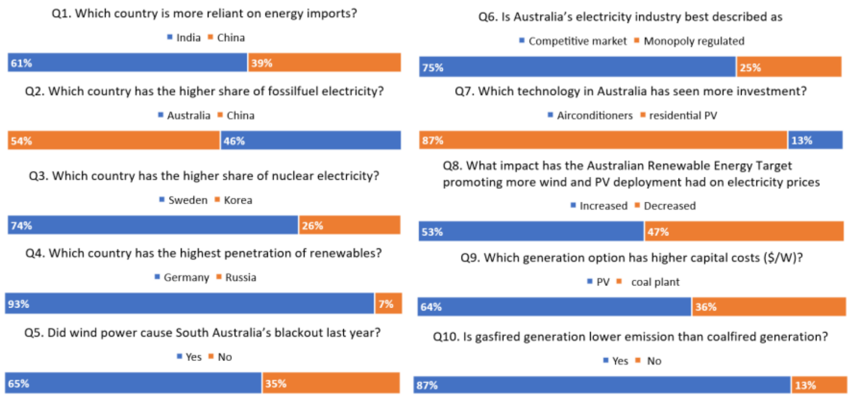


Figure 3: Students response to some challenging questions which seem obvious

Figure 4 shows three quizzes with the student response distribution. The left charts show the students perception, while the right figure shows a set of calculation-based quizzes designed to step through students with step-by-step feedback and online change in assumptions. Students tend to struggle with the calculations in the first steps and then after the feedback and discussion about the quiz they would catch up on the calculation and generally do a better job in later part of the question. The questions were designed to first present a simple concept, then make the point clear for the students followed by adding real world questions that for example make simple cost-benefit analyses more complex in practice. The on-line quizzes, with immediate class feedback on aggregate student responses was of interest to the students, and particularly helpful to the lecturer.

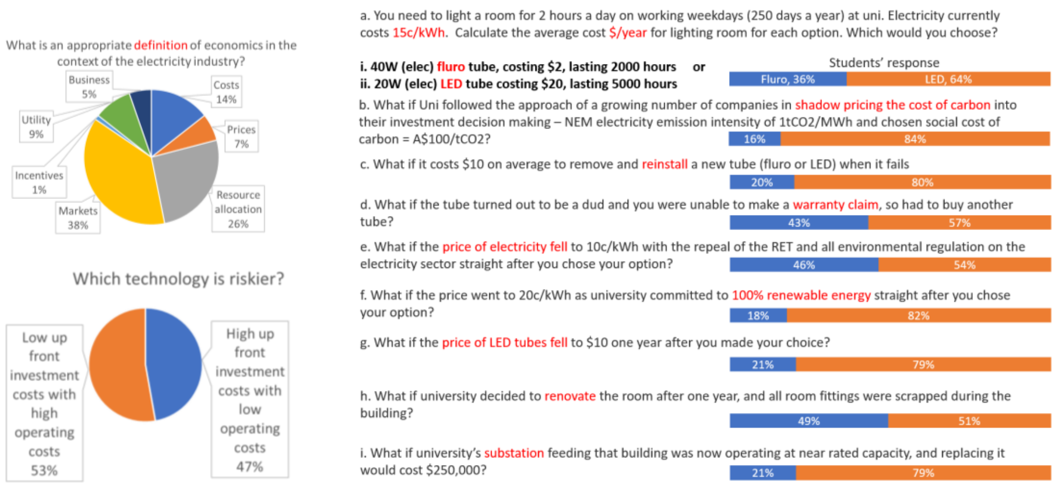


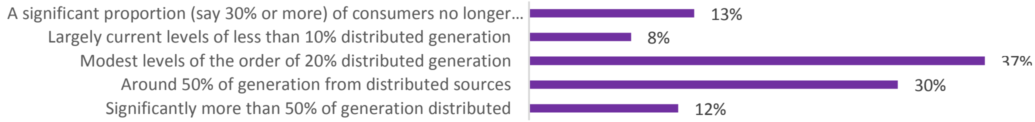
Figure 4: Three sample quizzes. Left: Students opinion on the definition and quick test on their perception of risk. Right: a series of calculation-based questions with dynamic assumptions

Another set of questions were designed to investigate the opinion of students which can reflect on both their previous experience and the knowledge gained in class. A particularly interesting example was a series of quizzes in the final two weeks of the course on some of the key 'open' questions about the future of the electricity sector. These included questions on how renewable, distributed, smart, decentralised and low carbon the Australian electricity industry would be in 2040. Figure 5 shows the response of students to these quizzes. This shows an important fact about how students' opinion about the future of entire electricity industry can dramatically vary keeping in mind that 2040 will be a fairly "mid-career" time for most of these students.

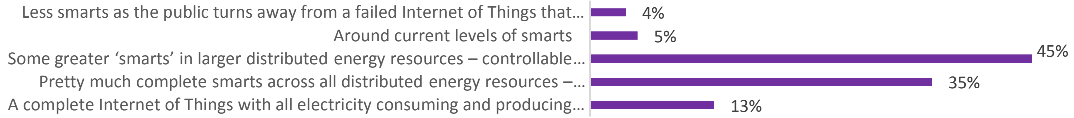
Group projects

Group projects provide students with a great opportunity to practice team work as a valuable skill in engineering projects. In this course students were asked to form group of five and nominate some preferred topics from a list of available topics. The topics were reviewed, and one topic was assigned to each group by the lecturers. They needed to then provide an executive summary to be reviewed by the lecturers, present the group "pitch" as a seminar in last two weeks and finally submit a group report.

What mix of centralised versus distributed generation do you see as most likely for the Australian NEM in 2040?



How smart the NEM will be in 2040?



What is the most likely mix of decentralised decision making?

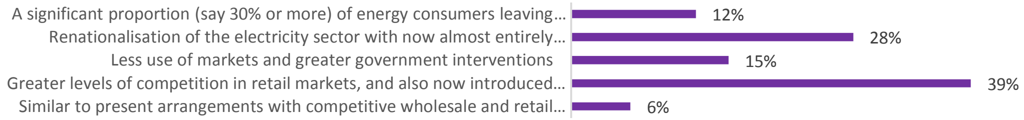


Figure 5: A series of quizzes asking about the future of the National Electricity Market

In order to provide students with an opportunity to communicate within and between groups, a forum was set up for each group, so students could discuss the progress and share research materials. Three other groups were assigned to each student to ask questions. There were around 60 groups (each had five students), therefore, in total each group received around 15 questions from other students. The students' activities including asking questions, responding to questions asked from their groups, attending the quizzes, and contribution in group project activities were evaluated and formed their "contribution mark". Figure 6 shows the steps of group project activities in different weeks. Students presented their work in last two weeks in a 4-minute presentation with real time assessment by all other students through a platform designed specifically for this using the university's online learning management system.

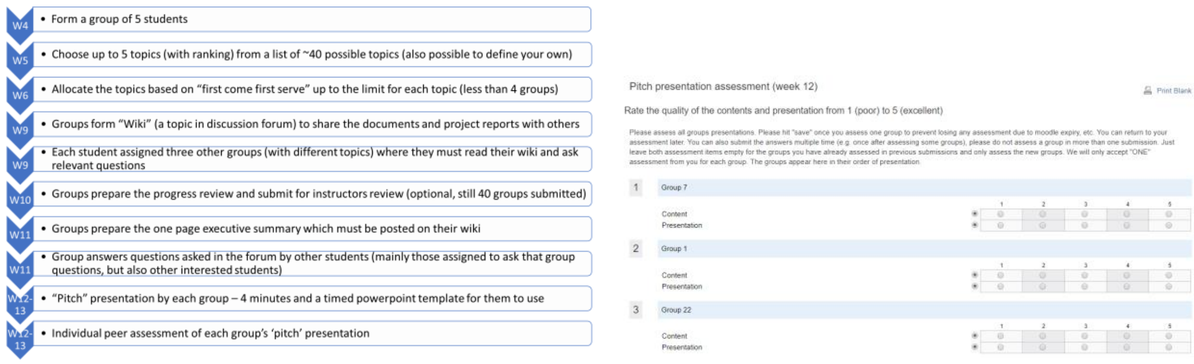


Figure 6: Group project work flow (left), a sample of online peer assessment (right)

Each student on average had 67 actions in their wikis, including more than 9 "posting" actions. As mentioned before, students' final seminar was assessed by the lecturers and also by all other students in class. The right plot in figure 7 shows the correlation of students assessment marks and the lecturers confirming a slightly different range which can be due to the fact that some students may not have been paying attention in the assessment. Although this seem to be a random behaviour which affects all groups, in order to minimise the impact of such a random assessment on the seminar mark, a pre-processing was done on the students rating. Students which seemed to mark randomly (those who assessed the seminar sooner than the actual seminar time (!) and those with very low correlation with the whole class) were removed from the assessment. Also the average mark given by students was combined by the lecturers mark by the weight of one to two which makes the students assessment's impact half of the lecturers'.

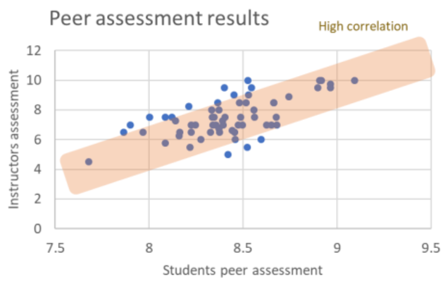


Figure 7: Correlation of students and instructor's assessment of the final seminars

Value of on-line activities

The final course satisfaction surveys – a centrally run, compulsory surveying – suggested that students gained value from the on-line tools. Overall, the course received positive feedback through this anonymous "myExperience" survey platform with a grade 4.94/6 as one of the few large courses in faculty of Engineering which could achieved such a high score. While this outcome is certainly the outcome of a wide range of factors, it is notable that the most positive feedback and comments were around the weekly quizzes which showed high students' engagement in quizzes. For our own analysis, the data collection of the on-line tools also facilitated our own analysis of student engagement. Figure 8 suggests some correlation between students' on-line participation with their final course mark as shown in the scatter plot. However, the relationship between final mark and students engagement is certainly not linear, highlighting the complexity of the student learning experience.

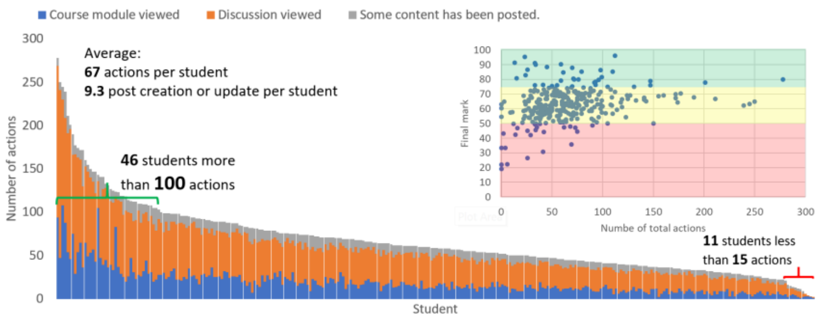


Figure 8: Number of actions per student and its correlation with their final mark (left

Conclusions

This paper presented a set of steps taken to improve student engagement and feedback in a large applied engineering course where in-class discussions and group work had become less and less feasible as student numbers grew. A series of surveys, quizzes, and group project framework introduced in this course was reviewed and some insights from this practice was listed. None of these on-line activities were in themselves highly novel. However, the overall experience of using these tools is hopefully of interested to other engineering educators facing similar challenges.

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