

# **WORKING WITH A DIVERSE CLASS: REFLECTIONS ON THE ROLE OF TEAM TEACHING, TEACHING TOOLS AND TECHNOLOGICAL SUPPORT**

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## **ABSTRACT**

A variety of teaching methods and supportive tools are at a lecturer's disposal. Comprehensive knowledge of such methods and tools and their effective use can enrich students' lecture experiences and increase their ability as well as willingness to learn. Teaching in a team requires patience and time commitment from all staff involved but can prove to be a good approach to iteratively elevate the quality of course content as well as course delivery. Actively engaging students in a lecture environment and usage of methods that encourage class participation are additional facilitators that can yield a richer learning experience. Employing a pedagogical as well as an expert focus in combination is found to be a valid approach for continuous teaching improvement in a university environment. These insights are based on findings and experiences gained from several semester of teaching an introductory course to operations management in a team setting but may be regarded as partially generalisable and applicable to other teaching requirements.

## **KEYWORDS**

Diversity, structure, cycles, teams, technology, teaching, methods, tools

## **1. INTRODUCTION**

This manuscript examines the teaching processes, benefits, and trade-offs involved when multiple lecturers cooperatively teach a single undergraduate course in operations management/supply chain management (OM/SCM). The role that technology plays as a facilitator of learning is examined in this context. The importance of this research is supported by the finding that team teaching can aid organisational knowledge development. Furthermore it supports the ability of staff involved with a class to improve the delivery of content to a diverse audience. It has been noted that internationalisation and the impact on university education "is a complex process that is as much about whom and how we teach as it is about what we teach" (Leask, 2001, p. 114), and internationalisation is a key driver of diversity in the classes taught. We are following this dual focus by examining both the content-matter of a class (the 'what') as well as pedagogical issues (the 'how'). Some of the steps taken are examined in a case study of a class that has been taught in a team with the use of technology and varied approaches to encourage active learning by students.

## **2. LITERATURE REVIEW**

The development of the New Zealand education sector closely mirrors that in Australia, where student numbers rose rapidly in the 1990s and diversity increased (Martin & Karmel, 2002). A diverse student body has positive benefits as they "represent ideal social forums for promoting cultural understanding; fostering tolerance of diversity; discovering alternative ways of thinking; and developing inter-cultural skills" (Volet & Ang, 1998, p. 6). Yet this diversity also represents a significant challenge to the instructors. With a high level of diversity in classes it becomes necessary to ensure that all groups of students are reached, so that we "get as many students

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as possible to meet professionally/academically acceptable levels of performance at as high a level as we can” given our available resources (Buckridge & Guest, 2007, p. 144). This has implications on engagement with the students in the learning process. One method that many instructors use is the incorporation of active learning techniques in class. Active learning refers to the learning process whereby students are engaged in content delivery and are therefore active in the learning process. This is usually achieved through incorporation of activities into the classroom environment (Prince, 2004).

One method of increasing engagement is by carefully designing in class activities. There are several examples of educational games and in-class activities that are suitable in operations and supply chain management classes. These include ‘Games and exercises for operations management’ (Heineke & Meile, 1995) and ‘Implementing lean manufacturing techniques’ (Page, 2004). It has been shown that the use of such games, where students have been given adequate time to learn the rules, can improve their conceptual understanding of concepts. This can be achieved without detailed instruction being given or required, simply through a process of learning by doing. This type of engagement is another form of active learning as students find that such “practices empower them in class and create new opportunities for interaction outside class” (Maruyama, Moreno, Gudeman, & Marin, 2000, p. 78).

### **3. CASE STUDY**

This case study is based on teaching of a second year course called ‘Introduction to Operations and Supply Chain Management’ which is the first full course that focuses on OM and SCM as main subjects in the University of Auckland in New Zealand. Prior to engaging in this course, students are introduced to several key principles in a first year course over a period of four weeks, whereas the remaining eight weeks of that particular course focus on information systems. Thus, with little background knowledge in OM and SCM the course aims to introduce the students to the breadth of related areas. Students gain an understanding of how various OM topics, e.g. forecasting, capacity management, or process design, link together. Furthermore, it increases understanding of how OM and operations managers play a role in businesses and in SCM. Over several semesters this course has been taught by two lecturers. One had taught the course alone previously, while the second became involved after a couple of semesters.

Through detailing aspects of the class, the structures and methods used, we highlight key findings and areas of improvement as we changed the teaching methods in the class to adjust to ‘how’ we could teach rather than ‘what’ we were teaching.

#### **3.1 Structures for team teaching**

The teaching team for the course consists of two lecturers and a course coordinator. Additional assistance was brought in the form of marking support or guest lecturing when appropriate. The semester is made up of twelve weeks which are divided by a mid-semester break into two halves of even length. The experiences described were obtained using the strategy that one lecturer always takes the lectures in the first half while the second lecturer has full lecturing responsibility in the second half. This approach ensures that the students would have the maximum time with each lecturer. Anecdotal evidence indicated that frequent staff changes are correlated with student dissatisfaction with the course and their overall learning experience.

##### **3.1.1 Lectures, labs, and contact times and assessments**

A block of two hours each week is used as lecture times and a second block of two hours each week is used for small-class size tutorials in a computer lab. The average class size is around sixty students which make it challenging to engage with all the students in a lecture setting. For the two hour lab tutorials the class is split in half as these are taught in two separate lab rooms. The advantage of the smaller tutorials with only up to thirty students is that there is more time spent working with smaller groups and engaging with individuals.

In addition there are also office hours which are handled by the course coordinator. The lecturers had frequently experienced that during a designated office hour they sit in the allocated student contact room and no, or few, students attend. This problem can be mitigated through using the course coordinator, who is involved in multiple courses, allowing the office hours for all courses to be scheduled at one point in time. If there is a substantial number of students that turn up the lecturers can be contacted and brought into the office hours as well. Furthermore additional office hours with the lecturers present are scheduled when the need arises, e.g. close to assignment due dates or tests.

Student achievement is assessed using several tools. There is an end-of-semester examination accounting for 45% of the grade, a mid-term examination that accounts for 20% of the grade, and a mixture of assignments,

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completion of modelling work in computer labs, and a case study, accounting for the remainder of the grade. Assessment items are spread over the semester so that students gain feedback as their learning progresses. As the course is a second year course the emphasis in student learning is on engaging with and solving of problems which is reflected by most assessment items. Only few assessments are based on pure reproduction.

### **3.1.2 Challenges from the structure**

One significant challenge of splitting the lecturing in the described way is the students' perceptions and attachment to specific lecturers. While this is neither good nor bad, and is not a reflection on the first lecturers abilities, many students say they "feel as though we just got used to" the first lecturer, upon being reminded that they are swapping lecturers later.

To cope with such aspects, several steps are taken to facilitate the change of lecturers. At the start of the course the students are introduced to the entire team of staff members. The second lecturer attends the lectures during the first half of the course, and participates in the in-class discussions (see section 3.2.3), or uses the opportunity to work on an article, review material, or read literature so as to not waste time. Already the presence and occasional comment appeared to familiarise the students with the second lecturer. Near the point of hand-over, the first lecturer takes great care to remind students that they will soon have the second lecturer leading the seminars. Finally, the students are exposed to the second lecturer, and spend time interacting with them, during the on-going lab sessions which are led by both lectures simultaneously.

A significant issue that the staff involved in the course is faced with is the consistency of the messages given to the students. Frequently students will email the same question to several staff separately. The potential to have several significantly different answers is a concern. As a preventative measure staff carbon copied the other members when they responded to messages.

There is also the question of equity when a student asks an incisive question about the examination or tests and receives a useful reply. Can it be considered fair that one student alone should benefit from this knowledge? It may be considered that valuable knowledge is equitably exchanged for insightful enquiries; however, the staff felt it more equitable if the answers were compiled into a Frequently Asked Question (FAQ) sheet that is accessible by all students. This ensures consistency of answers to all students and makes full information available. It furthermore reduces the time spent answering individual student question as students can be referred to the FAQ sheet. The downside is the preparation time to compile these FAQs, particularly near test and exam times to ensure the information displayed remains current. It also needs to be clear who is in charge of necessary updates and how much time can be allocated to this task.

Working as a team does require an investment of time and energy of all staff. It may be seen as being 'inefficient' due to the significant coordination times. However, the coordination and the understanding on the part of all staff that is gained can also be seen as rather valuable. There are many examples that illustrate the advantages of team teaching with regard to the course delivery and administration tasks. E.g. mistakes in assessments may be spotted and corrected. Ambiguities or poorly worded assessment items may be noted and corrected. Meeting due dates and deadlines is the responsibility of all staff involved and is therefore rarely forgotten. The team teaching experience shows that inputs from several heads are certainly better than from one and can result in a better structured and well managed course.

## **3.2 Benefits to students**

### **3.2.1 English as an additional language**

The language of instruction in the course is English. Many students in the class face difficulties as the language of instruction is a second language for them. In any given semester the mix of students in the class has approximately consisted of around 50% New Zealand born with strong English language skills, around 25% from Asia, and 25% from elsewhere around the world. This is catered for in several ways. Firstly, one of the lecturers shares English as a second language but is fluent and has great empathy with the students. Secondly, great care is taken with regard to the verbal as well as written communication to the class.

Whenever material is presented to the students, or assessment items are prepared for distribution, the material passes through several checking phases. This enables any ambiguities to be picked up and identifies areas where the wording or language used is not adequately clear. The end results of such revision processes are assessment items and instructions that are more clearly understood by the students. This results in an enhanced ability to complete all assessments and therefore increases their chances to achieve a high grade.

The revision process occurs through the use of a shared staff drive and 'comments' added to Microsoft Word documents. This allows members of the teaching team to jointly access and edit documents.

### 3.2.2 Use of lecture recordings

Not all students are able to attend all lectures as some students work full/part time, fall ill, or have other commitments and therefore miss several classes. This can be catered for through lecture recordings. The lecturers use a tablet PC and PowerPoint slides. When an annotation is required, or a written note or ad-hoc diagram, this is completed using the tablet PC pen, with the result being shown in real time using the computer projector. Along with the slide content and the annotations the lecturer's voice is recorded using a wireless microphone, allowing the lecturer freedom of movement.

The uptake of the lecturer recordings is well noted and well accepted by students. One student that has English as an additional language (EAL) noted that using the recordings they could "replay that bit of the recording over and over until I understood what you meant." If the student fails to understand something the first time around they will be capable of understanding it the next time. It was furthermore found to be very helpful for the exam preparation and might have prevented exam related questions as students were able find answers by listening to the recording again.

### 3.2.3 Interactivity in the lecture

Few students want or desire to sit passively through an entire hour-long lecture. To counteract this behavior and encourage participation the material and flow is broken up at least once an hour, ideally twice, through the presentation of an in-class exercise or discussion. This may be as simple as posing a question to the class and asking them to discuss it in pairs or small groups.

This approach creates several benefits. A key benefit is that students remember more when activities are used in the classroom setting (Prince, 2004). Students that had isolated themselves previously may be required to change and also become engaged with other students in the class and form relationships. While many of the students that have EAL challenges may prefer to take a non-participatory role, having several staff present enables the instructors to target such students and work with a small group of them to elicit their responses or perceptions in the exercise. If this step is not taken these students often choose to sit tight and stare stoically ahead. Having multiple staff present gives the opportunity for more engagement with students.

Finally, the use of the tablet PC allows the lecturer to physically take the device around the room to record notes or key points from discussions that they overhear or take part in. This can then be incorporated into a larger, class-wide, discussion about the exercise.

Our experience has been that there is greater engagement in the class-wide discussions when there has been more engagement in the earlier small-group discussions. One of the most important benefits is that the approach allows real-time feedback on what concepts students are struggling to comprehend. If another staff member notices an issue the primary lecturer can be notified and might be able to return to previously covered material to reinforce the students' understanding of this issue.

### 3.2.4 In-class games

The lecturers enjoy using games to help them teach key concepts to the class. These included the beer game, the candy factory game, a yield management game, and the red bead game (Walton, 1986).

**The beer game** is used to demonstrate the bullwhip effect and the impact that this may have on the supply chain and help students to understand how it may be mitigated (Lee, Padmanabhan, & Wang, 1997). While it may be played using boards and tokens, in the form that originated with the MIT development, the lecturers found that the approach was effective but tedious. Students often struggled and made mistakes with backorders which were frequently unapparent until several periods later. By the time students noticed that there was a problem it had become a time consuming task to unravel the mystery of what went wrong when and where. As a solution to these problems the lecturers employed a computerised version of the beer game in the labs. The students still worked in teams of four, but the computerisation enabled the students to focus on the mechanics of the game as it removed the difficulties associated with calculating the inventory and backorders, allowing the game to progress smoothly. The statistics and results could be immediately compiled for a comparison of the class. Teaching staff could select a good example and bring it up on the projector to illustrate the key teaching points related to the beer game.

**The candy factory game** is used as a demonstration of lean thinking. In the exercise there is a series of three workstations. The units of production are a cup containing 15 pieces of wrapped candy. The first workstation is given a unit of product to process. The second workstation counts the candy to confirm the correct number is present, and the third workstation places the candy in the cup and returns it to the instructor. The rate of introduction of material into the system is varied from a slow pace, choking the system, to a much faster pace, where the bottleneck is immediately apparent as inventory builds up. Students can time the period it takes for a

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given customer order to pass through the system when there is little inventory or plenty of inventory. The game is simple, quick to play, and students respond well. It is frequently used as an example in the exam when students seek to explain their answers in inventory related questions, demonstrating that active participation supports the understanding of OM concepts.

**The yield management game** is played in the computer labs and is based on the game presented in the text book 'Service Management' (Fitzsimmons & Fitzsimmons, 2008). Potential offers of customers are presented, one per slide, to the students, who act as yield managers for an airline. A decision is made whether or not to book the passengers in an attempt to maximise revenue. Finally, the actual numbers of passengers that turn up are revealed. Playing this in the computer labs allows students to download and use a spreadsheet to track their revenue so that at the end they are capable of determining amongst themselves who achieved the highest revenue. Despite the fact that the principles of revenue management, including a booking limit, are discussed in the previous lecture, few students appear to make the connection and only half admit to using the concept when playing the game. This offers a good point to remind students that the knowledge is not just theoretical!

**The red bead game** was only used in one semester to illustrate the impact of variation on a process. It proved to be less popular than the other games. It was run in the lab with 6 out of 30 students taking part. In the delivery initially too many rounds were played which proved to 'drag out' the experience; fewer rounds would have conveyed the same message without wasting time. Students also appeared to find the more abstract nature of the game and learning challenging to take on board. Thus, a redesign of the original concept by Walton (1986) may be re-introduced at a later stage.

### **3.2.5 Laboratory sessions**

The labs are used for two purposes. Firstly, they enable the students to engage and work with one another effectively, and secondly, they allow the use of computers to aid the educational process.

Part of the course involves enhancing skills in spreadsheet use. They are given common OM problems to model and solve in spreadsheets. They are provided with written instruction and also a short screencast recording (using the same recording technology as for the lectures) that walks them through the problem. Over the semester the problems become increasingly difficult with fewer explicit instructions. Collaboration amongst students is particularly encouraged and students usually form groups that they sit with each week and help one another when they have difficulties. Students who are more comfortable with the material are also encouraged by the lecturers to help other students. This forms strong bonds amongst the community and reduces the impact of diversity. The same groups frequently collaborate when preparing for assessments. Students appreciate the contact time with the lecturers and several students say that labs are their favourite part of the course.

In running the labs, if possible, two staff members are present. One acts as a presenter and facilitator while the second acts as a 'runner' to answer questions and provide specific help. One half of the time in the lab is frequently used for spreadsheet modelling while the other half is used for activities more aligned with games, case studies, presentations, or discussions. In the smaller lab groups it is possible to ensure that all students participate in the discussions and contribute something valuable to the class.

### **3.2.6 Reflections and further information**

Sometimes an insightful question was asked near the end of the allocated lecture time, or required further thought and reflection on the part of the lecturer to answer adequately. Under these circumstances the lecturer is able to utilise the tablet PC and compile a special recording which can then be immediately uploaded and made available to the class. The approach allows a measured, precise, clear, and succinct presentation of the answer to a question. Students that may struggle with the presentation of complex concepts are able to repeat the recording several times until they fully understand what the lecturer is explaining.

### **3.2.7 Informal student feedback**

It was found very useful to conduct an informal feedback session about four weeks into the course. This involved answering some open-ended questions which are handed to the students during the lecture or lab session. Feedback was requested with regard to 'aspects that students liked/disliked' and 'potential areas for improvement'. The student answers are anonymous and therefore result in honest and useful feedback. Overall incorporation of these feedback sessions have been highly useful and are a standard part of the course as they helped to highlight areas of concern with regard to the course delivery and areas for improvement.

### 3.2.8 Discussion boards

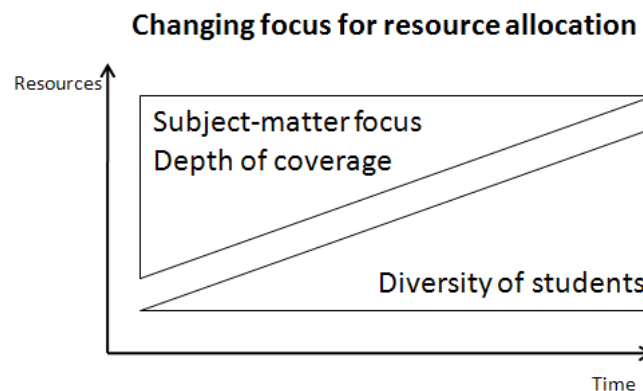
When online discussion boards were initially set up there was only little student activity. The level of interactivity could be increased, although the staff was wary of having to spend considerable amounts of time monitoring and answering questions on the discussion boards. Once such a tool is established students appear to demand constant availability of the lecturer to answer their questions. If discussion boards were integrated into a course more completely it is perceived that they may function as a many-to-many communication tool, allowing students to engage with one another outside of the teaching areas. Students can be encouraged to answer the queries of other students to help provide clarity in the material covered and discussed.

Greater levels of participation may be reached through providing marks for the value of contributions made by students. Such a practice may of course result in even greater coordination and administration time. Thus, discussion boards are mainly seen useful to foster inter-student communication.

## 4. DISCUSSION

Reflection on the teaching and learning forced the teaching staff to re-think both the content of the material delivered and their role in content development. The staff have increasingly focused on the delivery and process of teaching to the students, a shift in focus that has also been discussed by other authors (De Vita & Case, 2003). Evaluating the situation led to the belief that the staff resources were being increasingly allocated in a manner that was reducing the subject focus of the material being taught. This was at first concerning as it involved significant investments of time and energy by the team of three staff involved with the class. The worry was that as there was greater diversity of students and more efforts went into working to accommodate the needs of the class, there would be less focus and fewer resources to invest into improving the subject-matter focus and the depth of coverage in the class. With limited resources it was initially envisaged that if allocations towards one aspect of the class increased, this would reduce allocations of resources to the other aspect of the class (Figure 1).

**Figure 1. Increasing focus on resource allocation to enable teaching of a diverse student body**



Being engaged in a class with a diverse group of peers benefits individual students (Gurin, Dey, Hurtado, & Gurin, 2002), and through increasing the participation and active learning in the class there should be greater opportunity to engage with other students. This may help to partially off-set the somewhat reduced attention to the subject-matter of the class. However, the shifting focus concerned individual staff members.

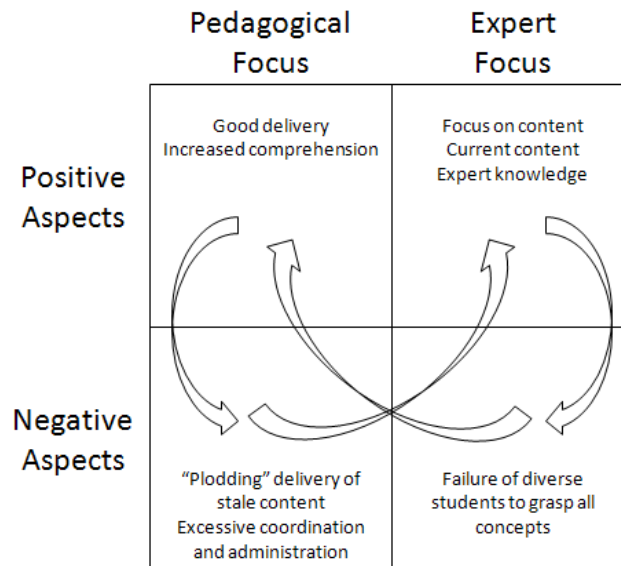
### 4.1. Cycles in the focus

Such a shift in resource allocations, as depicted in Figure 1, presented a one-dimensional perspective of the situation. Further reflection encouraged the development of an alternative model, as the realisation dawned that there was increasing focus, again, on the class content despite considerable pedagogical disruption. It was realised that there were positive and negative aspects to each focus, which in turn, propelled evolution of the focus to a different area.

Initially the emphasis had been on the content of the class, and development of contents by experts in the area. This had positive benefits as it ensured that material was current and expert knowledge was utilised. However, as feedback was received from students, it was realised that there was a failure to grasp the concepts being presented. This resulted in a shift towards a pedagogical focus, with an emphasis on improved delivery of

material to increase study comprehension. Thus, there must be a simultaneous focus on pedagogical aspects and expert-orientated content.

**Figure 2. Cyclic nature of dual focus**



Terenzini, Cabrera, Colbeck, Bjorklund, and Parente (2001, p. 527) note that “what happens in a course is far-and-away a more powerful predictor of learning outcomes than is the level of classroom diversity.” If the delivery was more important than the diversity, it may be still driven by the diversity. The cycle presented in Figure 2 explains this paradox. Diversity can lead to greater focus on ‘what happens in a course’ which can, in turn, strengthen the outcomes for students.

However, it is more than just ‘what happens’ and there needs to be focus on how it happens, as “lecturers can take heart that their passion and enthusiasm, combined with an interactive and structured teaching approach, can greatly enhance the learning experience of students and lead to higher levels of attendance and academic achievement” (Revell & Wainwright, 2009, p. 221). Future work in the class involves working on the content material to structure it in an appropriate method to incorporate aspects of Bloom’s Taxonomy (Krathwohl, 2002), ensuring that the understanding demonstrated is appropriate at the class level.

Another benefit of the focus on the pedagogical requirements of the class is that it can help to reduce the adjustment period of students which can be beneficial to their learning (Zhang, Sillitoe, & Webb, 1999). This part of the learning process had also concerned staff as there would regularly be a large amount of international students, from parts of Asia, Europe, and North America present in the class.

## 5. CONCLUSIONS

Through the exploration of the stage two university course ‘Introduction to Operations and Supply Chain Management’ and the teaching-orientated improvements made, it is seen that a dual focus on both content and delivery is necessary. Methods for improving the delivery are outlined through the case study. A case is made for a dual consideration, with a cyclic swing between a focus on pedagogical issues and expert-input to ensure effective content is included. This approach avoids over-emphasis on either focus, hopefully leading to a reasonable trade-off between approaches and an improved outcome for students.

The findings of this research are limited in two key ways. The first is that the results and findings are mainly derived from the lecturers’ perceptions of reality. There was little objective data collected from the students as part of this research and some available data were unable to be used due to ethical restrictions. This presents an important avenue for further enhancing the rigor of the study going forward. Future research would frame the investigation differently and emphasise the development of a survey tool to gauge whether or not such approaches improve student outcomes in the face of diversity in the classes. However, the cyclic framework can be seen as generalisable to classes beyond those in operations and supply chain management; the generality of the framework should encompass similar challenges faced by other classes, departments or faculties. In this way it may provide a valuable foundation for a program of continued improvement in educational programme structure and contents.

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