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Working on an Assignment with People you'll Never Meet! Case Study on Learning Operations Management in International Teams*

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This paper examines the results of an international team-based operations management assignment that runs between two universities. The work shows the benefits of giving students a taste of real-life operations management problems both from a technical point of view as well as the challenges faced when working to short timescales, with unfamiliar team players and across time zones. The work has generated valuable understanding of the approach required to set up such inter-institution assignments. It has enabled a process model to be developed to allow others to extract the key stages required for setting up and running them.

Keywords: operations management; international team assignment; educational technologies

INTRODUCTION

Characteristics of operations management

OPERATIONS MANAGEMENT is a broad discipline that encompasses the activities required to deliver a product or service to the customer. One definition for operations management is [1]:

> The business function responsible for planning, co-ordinating and controlling the resources needed to produce a company's products and services.

Activities range from sourcing materials to transforming them into saleable product to delivering to the customer. Issues involved range from quality of product to the motivation of staff.

With the increasingly global nature of company activities, driven by expansion into new markets and outsourcing, the nature of the operations management activities is becoming increasingly complex. Operations management is increasingly an international activity with parts of companies, customers and suppliers residing in different time zones and having different cultural approaches. Product introduction times are falling and customers are expecting higher quality, faster response times and lower costs. The way in which companies respond to this has resulted in a wider distribution of facilities that they are working with, more frequent communication across time zones and increasing use of IT to communicate coupled with a decreasing level of personal contact. The use of IT ranges from communication by email to sharing data through websites. Additionally, where teams are working together on projects it is common for the team members to be physically separate, sometimes in different time zones. Whilst these characteristics have described a typical picture of operations management activity it is recognised that these same characteristics could be used to describe other disciplines [2].

Traditionally taught operations management can include some of the complexity but it is more difficult to give students a taste of working with different people with different working patterns who they may never meet, let alone talk to. Case studies can give insight to this and lectures can provide theory with examples but experiencing this environment first hand offers an invaluable learning experience.

Aim, objectives and contribution

The aim of this work is to introduce a case study based assignment that will address both the core academic needs of the syllabus as well as contribute to students' transferable skills by working in international teams. Specific objectives are:

1. Develop a case study and utilise a web-based portal for international team assignment.
2. Integrate and deploy the case study approach into the curriculum.
3. Assess the impact on teaching quality and student motivation.

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The novelty of this work is getting students studying at different institutions on different degree programmes to collaborate to apply their understanding of operations management concepts to solve a typical problem. The contribution of this paper is to introduce the case study approach and from it present a process model with guidelines that offers others an approach to setting up similar types of collaboration for their students.

Methodology

The methodology to investigate the effectiveness of this teaching approach will follow a qualitative rather than quantitative approach. Qualitative research is appropriate to single case studies from which deep, rich data can be obtained for holistic, discovery-oriented work [3]. In making a decision whether to follow a positivist or phenomenological approach it was decided that the latter would be most appropriate as 'it is not primarily concerned with explaining the causes of things but tries, instead, to provide a description of how things are experienced first hand by those involved' [4]. The phenomenological approach will involve description and subjectivity rather than numerical analysis and objectivity.

Having followed the phenomenological and qualitative approach to the research the decision on how the research would be conducted was made between case study and action research approach. The case study approach would have required a greater number of cases and detachment of the researchers. Therefore this was discounted on the grounds of the novelty of the work resulting in few instances of this work being carried out and the deep involvement they would have with this implementation. Action research was much more appropriate due to the uniqueness of the work, the deep involvement of the researchers and potential for the researchers, as teaching staff, to modify the scenario as it is being taught. As this paper switches from research approach to teaching approach, the deployment of this action research scenario will be referred to hereafter as the 'case study'.

The survey is an obvious candidate for the research instrument to collect large quantities of data very quickly and efficiently. For a single case study repeated over two years with deep involvement of the teaching staff then a survey would be an appropriate instrument to collect simple factual data from the students but the deep, rich detail would be primarily collected through direct observations of the students, workshops, tutorials, email queries, teaching portal activity and observations made in student reports. Specific survey based tools that will be used to collect summary data are as follows:

- confidence logs [5] to track student confidence throughout the module;
- assignment specific questionnaires on the addressing issues such as how well the students thought the assignment had helped them understand the underlying theories;
- module level teaching quality questionnaires to understand the overall impact.

Assignment and module performance would be considered but this would be used carefully and taken in the context of the overall cohort performance across all modules taught at that time. In addition, secondary data from literature would support the work.

Teaching challenges

Learning is inherently a student-based activity, suggesting that teaching should be student-focused rather than the more traditional teacher-focused [6]. The predominant view of education has moved from teacher-focused education, where the teacher communicates information and knowledge to the student, who absorbs it; to student-focused education, where the student engages in activities which develop their understanding [7]. Some forms of this are known as independent learning, also known as student-centred learning. One means of promoting this approach is to design modules to provide students with lectures for structure and open-learning materials for student-centred study [8]. To enhance this student-centred approach case study based assignments can be used in which students are guided to carry out their own analysis and present recommendations.

In developing any problem for students to solve, if it is too simplistic then students can use declarative knowledge that describes the fundamental precepts and facts to derive a solution. Procedural knowledge includes methods and tools that exploit declarative knowledge. Once the student has mastered application of such knowledge then additional learning slows. For more challenging open-ended, ambiguous and ill-structured problems the student will have little direct experience of solving and the simple application of procedural knowledge is insufficient. Developing expertise in such problems is sometimes referred to as adaptive expertise [9] and acquiring such adaptive expertise requires a different learning environment.

By utilising assignments that are open-ended, ambiguous and ill-structured students can be guided to adapt and gain confidence in obtaining solutions and checking their validity. Students will engage in much deeper learning and deploy higher order cognitive skills. Over time a better understanding will develop of solving problems in a complex environment in which inaccurate, vague, missing or redundant data is present.

Feedback is an essential component in this learning process. This feedback for students can come from reviewing the results of their analysis, from their peers or from their tutors guiding the learning process. By testing out their understanding and gaining feedback, students can elicit further knowledge to extend their understanding. Feedback features in most theories of learning, an

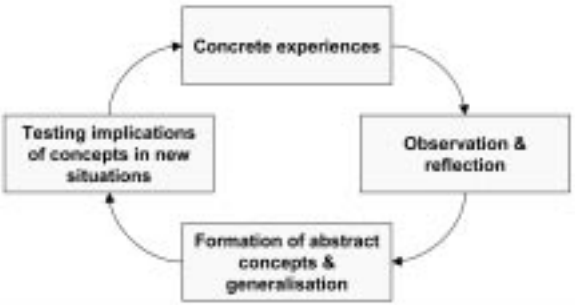

Fig. 1. Kolb Experiential Learning Cycle [10].

example of which is the experiential learning cycle [10] shown in Fig. 1 in which theories are presented, applied and then as a result of this experience the learner observes and reflects on their activity.

Another means of enhancing the student learning experience is the introduction of team working. This enables staff to present more complex problems and students to undertake a challenging assignment as well as to learn from other students in the team. The use of team working in engineering education aligns to the requirements of the engineering bodies accrediting courses both in the UK and the US. The UK Engineering Council's UK Standard for Professional Engineering Competence (UK-SPEC) [11] has a requirement 'C3 Lead teams and develop staff to meet changing technical and managerial needs'. The Accreditation Board for Engineering and Technology (ABET) in the US has required programme outcomes of '(d) an ability to function on a multidisciplinary team' and '(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context' [12].

A challenge for engineering educators is how to develop a learning environment that provides student-centred learning with support mechanisms and feedback that is combined with the international team challenges faced by practitioners and promoted by accrediting bodies. The remainder of this paper introduces an international team based operations management assignment. The case detail, supporting infrastructure and evaluation are described.

CASE STUDY: UNIVERSITY OF STRATHCLYDE AND IOWA STATE UNIVERSITY

Overview

The case study results from collaboration between two universities, the University of Strathclyde in the UK and Iowa State University in the USA. The University of Strathclyde's DIDET project [13] aimed to develop a digital library and shared workspace concept and infrastructure in which students collaborate to develop resources, which are then used to solve engineering problems. Independently, Iowa State University had an initiative to bring an international focus to its teaching, both in the material delivered and the method of delivery. With synergy in the teaching of operations management the universities used their initiatives as a means of working together for the last two years.

The operations management modules for the students run concurrently and independently at each university for the lecture and laboratory based teaching and the students collaborate on their main assignment. The assignment focuses on the planning of sales and production of a product worldwide. It provides students with an opportunity to demonstrate their ability to apply theories presented in the lectures as well as a vehicle to experience the complexity and challenges of operations management in practice.

Students experience the international dimension by the technical content of the assignment problem but most importantly through the international team structure to solve the problem. The problem set is a hypothetical food manufacturer based in Scotland, expanding the market for its products to countries including USA, India and Australia, thereby forming a global supply chain. The company's main product is haggis, a traditional Scottish dish made from sheep meat and oatmeal, which would be modified to form a product range that would address the needs of local markets.

Students are formed into teams of four, with two members from each country. To date there have been more students in the UK operations management module than in the USA so a number of UK only teams are formed using students from different degree streams that would have not met previously. Hence, where possible the less typical mixed project group structure [2] has been used. Students are introduced to the assignment concept, then the supporting technology, then they meet their other team members before eventually going on to embark on the assignment and submit it. The timescales and phases of this process are shown in Fig. 2. The figure shows how the work here maps to the stages that online course participants experience developed by Salmon [14]. The 'Access and Motivation' stage brings students into contact with one another with support from the tutor. Next the students socialise and develop a sense of group identity. The 'Information Exchange' and 'Knowledge Construction' stages are where the students identify the information required for the assignment and manipulate it in their teams. The final stage is where the students reflect on their work.

The idea of international collaborative team assignments is not new. For example Herder *et al.* [15] describe the results from an international design assignment with 24 students accounting for a significant proportion of the module assessment. Grimheden and Hanson [16] describe a small mechantronics collaboration between international student teams and provide insight into the student reaction. MacKay [17] describes a larger

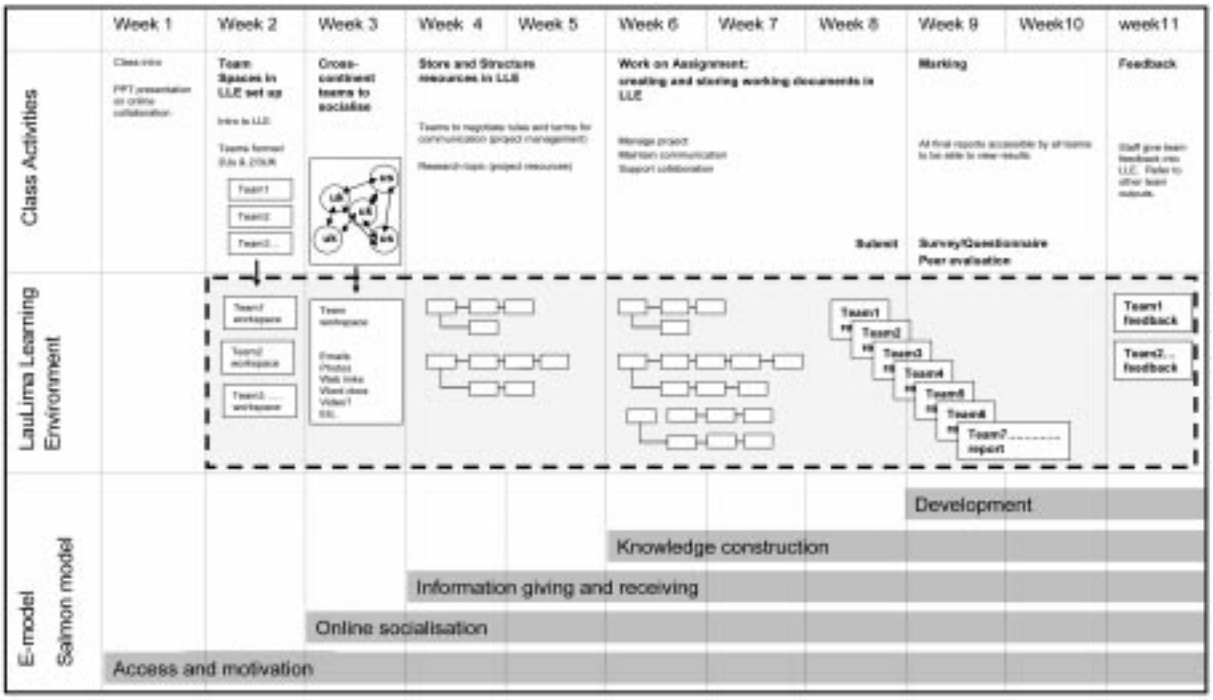

Fig. 2. Timeline of the class activities against the supporting technology and theory.

international collaboration with design students. Qamhiyah and Ramond [18] describe the integration of international engineering education in the area of design and draw extensively from student feedback to provide advice for others setting up such collaborations. Bufardi *et al*. [19] describe the design of a global product by international student teams. Unusually, this work includes an industrial collaboration. The work in this paper differs in that it looks at a sustained collaboration with a large number of students for a relatively small assignment (in marks terms) in the operations

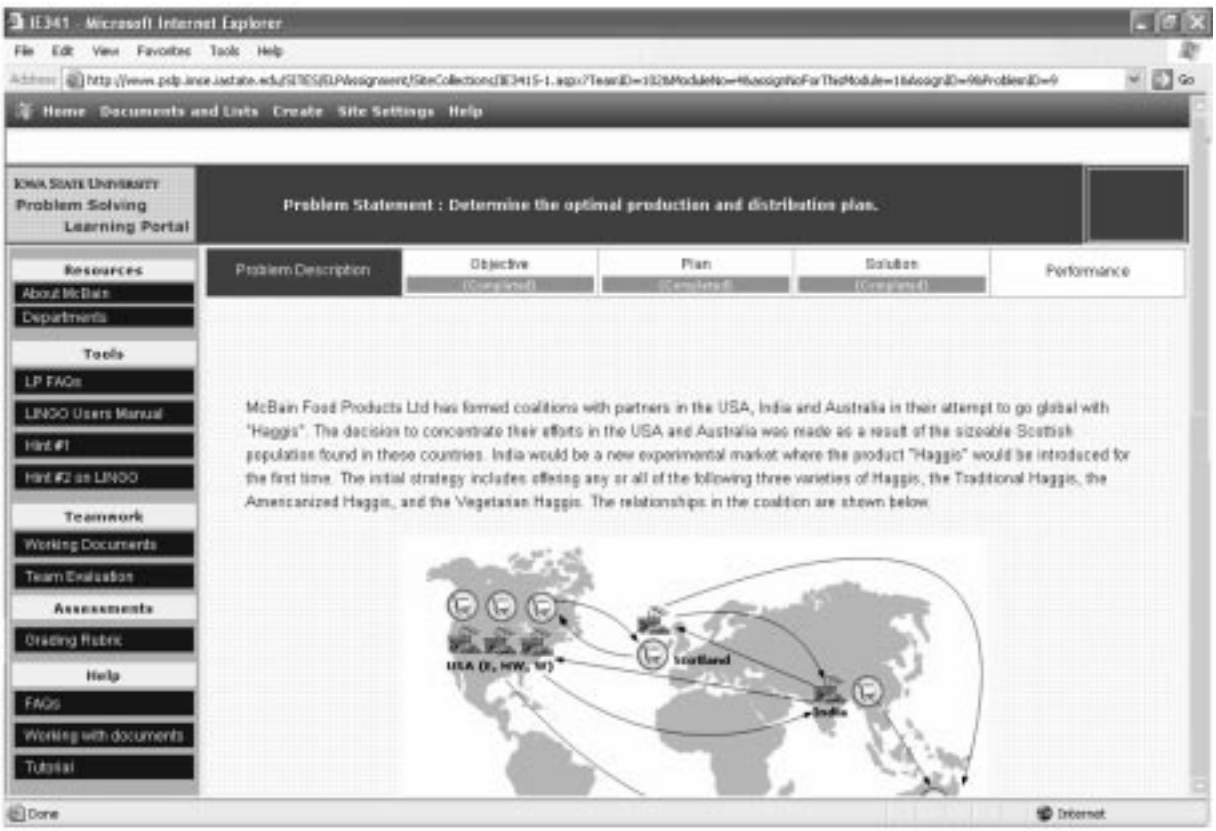

Fig. 3. Assignment introduction screen on the Engineering Learning Portal [20].

management discipline and develops from this a model for other implementations. In developing the model key learning is drawn from the international collaborations that have preceded it.

Technology supporting the assignment

It is recognised that the student teams will require technology to support their assignment activities to cope with the fact many of the team members will never speak to some of their team let alone meet them due to the distances involved. The technology would also support them in working across time zones (a six hour difference in this case). Most of the technology the students use is Internet-based but some did use mobile telephones/cell phones for SMS texting.

The main system that the students use is the Engineering Learning Portal [20] developed and administered in Iowa State University. ELP hosts the assignment, templates to help solve the assignment and the means by which the assignment is submitted. A screen shot of ELP is shown in Fig. 3.

The ELP provides the problem description, data on each market and the operation of each manufacturing site worldwide. Most of the data the students require is provided, however, some of the data is redundant. This vagueness in the data is one of the mechanisms used to force student teams to derive individual solutions and build confidence that their analysis is credible. The ELP has three phases of Objective, Plan and Solution. The Objective phase is completed very early in the assignment to encourage early progress and to give staff confidence of student understanding. The Plan phase involves the students identifying and collating data for their analysis. The Solution phase requires the students to analyse the data and upload their solution.

ELP encourages the students to reflect on and evaluate their progress. Against each phase of Objective, Plan and Solution students give reasons for their decisions. Peer assessment is deployed as well as self-assessment; the assessment rubrics that the staff will use are available to the students to reflect on and self-assess their work online. As well as using email to communicate within teams and between staff and teams, a number of other software packages are used, e.g. MSN Messenger and Skype.

In the first year of operation the LauLima Learning Environment (LLE) [21] was used as a means of storing and sharing documents and recording decisions made. LLE allowed student teams to share background information about themselves, including interests and photographs. Students also used LLE to store working documents prior to submission into ELP. The experience of the first year resulted in LLE being discontinued, not because of its usefulness but because of the learning curve that the students had to go through to familiarise themselves with more than one core package was distracting from the assignment work. Other applications used were MSN for instant messaging and Skype for Internet voice calls. Using less tools means less supporting resources are available to the students but it results in an easier and smoother implementation.

Implementation

The work to build the functioning relationship between the two institutions and implement the case study began in late 2003. The first implementation of the case study ran in Autumn 2004 with a total of 140 students, 52 from US and 88 from UK. The following year in 2005 students numbered 124, with 44 from USA and 80 from UK. There were four members per team with a majority of teams USA-UK and some UK only due to the differences in student numbers at each institution.

The case study and dominant IT system, the ELP, was developed by Iowa State University with the expectation that the next case study will be developed by University of Strathclyde. The case study style of clear overview but incomplete data, redundant data and non-obvious solutions matched the styles operated previously by both universities hence the implementation and operation of the case study was smooth.

Learning outcomes for the UK 'module' and US 'course' were aligned to the degree learning outcomes and in turn the accrediting body expectations. Clear documentation was developed for the students at module and assignment level on the learning outcomes and the assessment criteria.

The students submitted their assignment solution into the ELP as the main category of assessment but additionally wrote evaluation reports for their respective universities. These evaluation reports provided a rich insight into the team and general assignment operation.

EVALUATION

The initial student reaction was one of excitement for most students, but disappointment for the 'excluded' UK only team members. There was an initial flurry of contact between team members but difficulties in collaboration and a lull in the schedule of activities resulted in frustration in the first implementation. The initial collaboration within certain teams had to be encouraged due to inactive or unresponsive members. Students quickly adapted to working with a time difference though many regretted either not setting up team rules or sticking to them as the assignment deadline approached. Anecdotally it was noted that whilst the UK students tended to want to work gradually on the assignment the US members tended to work in much more intensive bursts of activity. Interestingly, there was no obvious difference in team activity between UK-USA teams and UK only teams despite their ability to meet face to face.

Formally, a number of mechanisms have been used to evaluate the effectiveness of the teaching mechanism over the two years. Of those that will

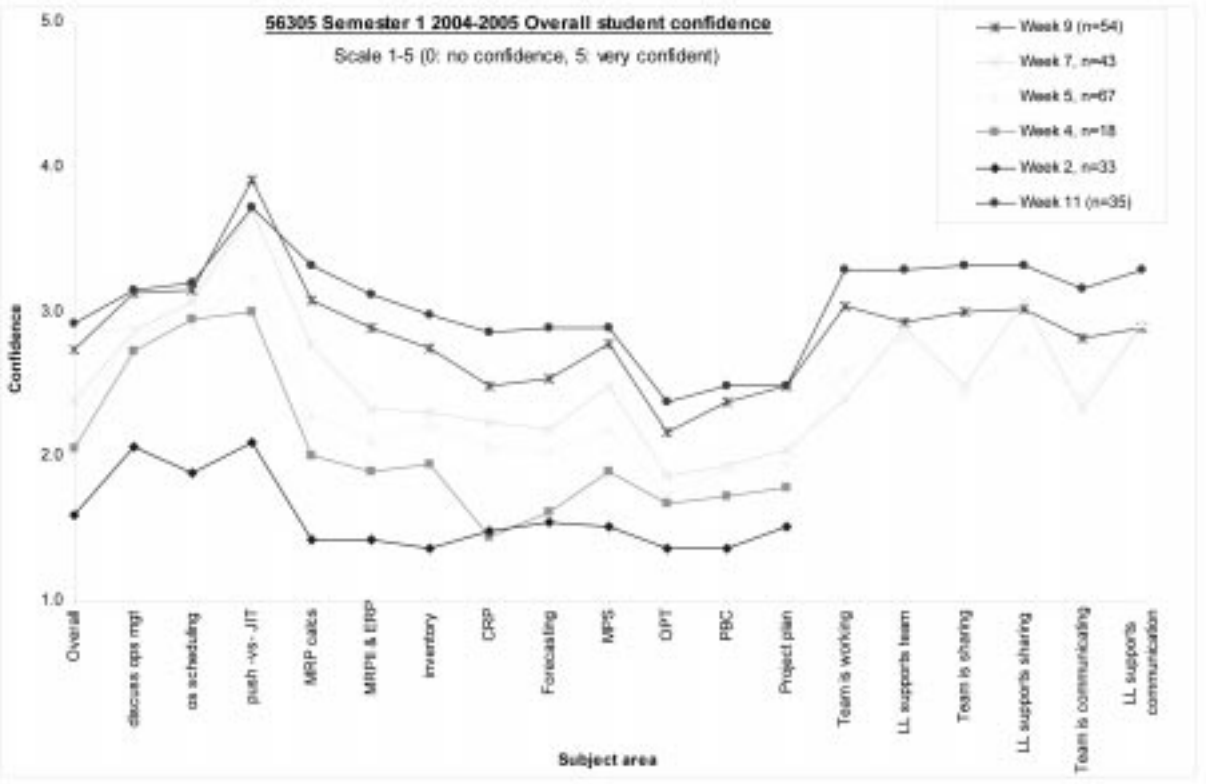

Fig. 4. Tracking of the student confidence against module objectives.

be described, two were applied during the delivery of the module and two on completion. The aim of the evaluation was both to monitor student progress for remedial action as well as to understand the effectiveness of this teaching approach.

During the delivery of the module, confidence logs [5] were used throughout to track the confidence of the students against the module objectives and syllabus. For the students anonymously completing the confidence logs this served as a reminder of the objectives for the module and for the staff using the analysis it was a means of addressing potentially poor performance early on. An example confidence log for the module is shown in Fig. 4. In the first year of the assignment a UK workshop was held by non-lecturing staff to reflect and share experiences, provide support and gain feedback from the work. The workshop resulted in recommendations on the following categories: team communication; information and resource sharing; team management. Many of the comments leading to the recommendations can be summarised as encouraging students to communicate more effectively and in a timelier manner with one another and for staff to provide better structures and preparation for the assignment.

At the end of the module performance data was available on each student on the assignment as well as student team reports on the effectiveness of the assignment and the supporting discussion. The performance of the students, whilst unreliable for evaluation of the teaching approach if used in isolation, showed a maintenance of, if not increase in, the standards achieved. Analysis of the student reports provided a significant amount of feedback on the progress of the assignment. Noting that this was not anonymous, some of the comments mirror those made in the workshop held and others show the excitement of working in international teams (or the disappointment of being in a UK only group).

Anonymous end of module questionnaires were used to evaluate the students' views on the assignment as well as the perceived effectiveness of the approach. On a scale of 1–5 the UK and USA surveys of teaching have shown a skew towards the top end of the scale; a typical example of the results is shown in Fig. 5 (the pairs of results show effectiveness of approach increasing team working and leadership respectively).

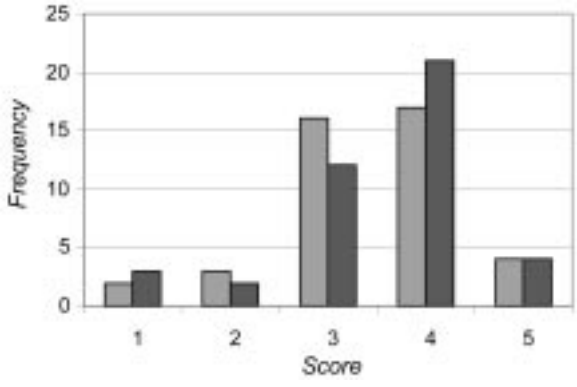

Fig. 5. Post-assignment survey response (average of all categories, 93% response rate).

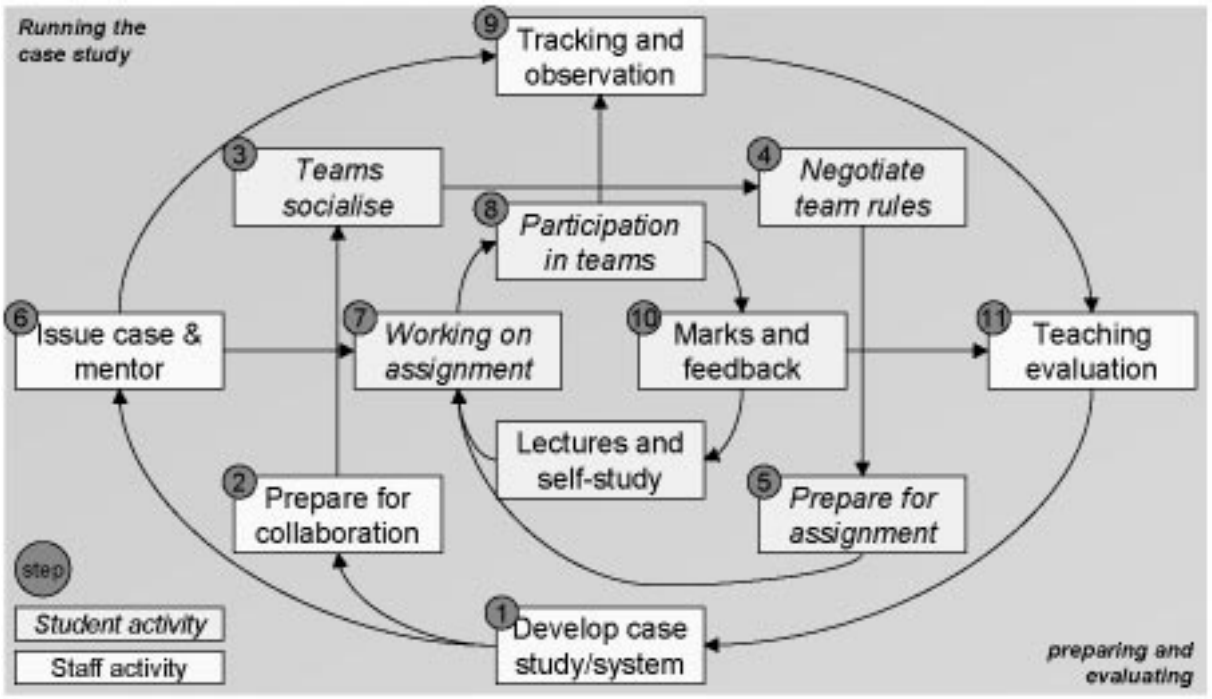

Fig. 6. Overall model for running the international team assignment.

In summary, the students have consistently appeared to enjoy the assignment both in terms of technical content as well as the international dimension. Typical negative comments have related to internal team communication and differences in work loads between USA and UK students due to external factors such as deadlines for other modules and the Thanksgiving holiday. From a performance viewpoint, the student performance has been at least maintained, as too has the students' perception of the modules.

EMERGING PROCESS MODEL AND GUIDELINES

The formal and informal evaluation of the running of the international teams assignment over two years has enabled a model to be built up to guide the use of such implementations. The model is presented in Fig. 6. The model contains a number of cycles that are predominantly student or staff-based. The cycles for students and staff in the model align to Kolb's experiential learning cycle described earlier. There is a diagonal split from bottom left to top right in the model that shows the transition between assignment activity from the preparation and evaluation activity. The model shows the sequence of major events, which are detailed in Table 1.

The model and detail of model steps provide a summary of the approach used and the guidelines for future implementations. Both the staff and the student cycles show how concepts are understood, applied and experience of the process gained enabling students to benefit from the approach and staff to enhance the approach used.

Work is ongoing on the development of this approach to teaching and future implementations may see collaborations between more than two universities involving students with different first languages and more widely varying cultural backgrounds.

SUMMARY

This paper has introduced the challenges to teaching operations management through an international team assignment. The use of case-based teaching for this discipline is well recognised and has been very successful. The work presented has shown how the case-based teaching approach can be extended to bring more 'real-life' into the investigation, analysis and solution of problems. In particular the problems of remote working, different cultures, different time zones, quickly forming teams and working with people you will never meet. The work draws on previous international team working reported for short-term assignments in operations management. For this type of discipline, although clear concepts and theories exist, their actual implementation in practical situations requires an appreciation of the conflicts, compromises and complexity that arises.

The international team assignment presented has provided novel extensions to case based teaching where students from different universities, on different degrees and variant modules collaborate in the short term to apply concepts and theories they have learnt. The way in which teams collaborate, share and manage information has been presented as well as the associated challenges.

Table 1. Detail of the steps in running the international team assignment

Step	Activity	Key issues
0	**Build links and align learning outcomes** Links need to be established with other institution(s). Motivating factors may be research grants, institutional initiatives, etc. Strong academic links and similar educational outlooks are important for smooth implementation. Given the likelihood of infrequent contact between academics at each institution it is interesting to observe that the same rules for students need to be practice by staff.	• Module teaching sequence and semester dates need to be similar across institutions. • Learning outcomes need to be similar overall and matching for those assessed by the assignment. • Assignment weighting needs to be similar. • Institutions' marking scales can be easily converted.
1	**Develop case study and system** The case study needs to be developed and ownership of this by one institution is helpful. The other institution can develop a subsequent case study. A supporting IT system to act as a repository is valuable for delivery and marking efficiency but the use of simple web pages and then email or paper-based submission should not be ruled out.	• Case study aim, data and solutions need to be well documented to ensure staff understanding. • Technology needs to be simple to avoid distracting students from the working on achieving the learning outcomes.
2	**Prepare for collaboration** Students are prepared for the assignment and shown how the assignment fits with the module objective and the skills set expected of operations management professionals. The teams are formed and logins prepared. The team membership is then released to the students.	• Students need clear introduction prepared with reassurances. • Short cases from companies help justify the use of the assignment approach. • Providing additional logins for new IT systems will inevitably cause teething problems. • Students need basic introduction to the IT systems even if they appear intuitive to use. • Release of student teams member names and emails needs to be simultaneous across institutions.
3	**Teams socialise** The student team members are encouraged to contact one another and maintain communication. Early and sustained contact between team members has been observed to enable teams to start assignment work quickly and work to smoothly.	• Encouraging students to make contact and exchange background, photographs, etc. is an extremely valuable icebreaker. • Students need motivation to maintain contact beyond initial introduction and a small task such as background theory documentation can be helpful here.
4	**Negotiate team rules** Teams are strongly advised to agree and document how they will work. Examples of the challenges they will face on the assignment and possible rules that they could use are presented. No team structures or rules are enforced on students.	• Students are strongly advised to negotiate team structures and rules very early on and to document these. Teams who do not do this typically express regret in hindsight. A rule may be days of working or the speed of response to an email. • Teams are encouraged to have a leader for each phase of the work.
5	**Prepare for assignment** Students know release dates of the assignment well in advance. A basic overview is given prior to the release of the detail to give them confidence and direct them towards learning material that will be required.	• Students are encouraged to plan the workloads, plan meeting times, understand the reference sources available to them, etc.
6	**Issue case and mentor** Once the case study for the assignment is released to the students then staff operate in a responsive mode to deal with queries and provide encouragement.	• Assignment is released by email notification and reinforced during lectures. • Contact time is set up for the students to seek help.
7	**Working on assignment** Students are given a period of time to work on the assignment, in this case three weeks.	• As students work on the assignment they are reminded to stick by the rules they set and of the assessment expectations.
8	**Participation in teams** Students work in teams and through individual activities and team contribution, then engage in deep learning and consolidate their understanding of the relevant parts of the module syllabus.	• Students work in teams but cultural/external differences may arise such as national holidays or other assignment submission dates competing for the students' time.
9	**Tracking and observation** Contact with students directly is important here to gain fast feedback. Student difficulties are identified and appropriate help given. A staged submission where students submit their detailed objectives for their solution to the problem is extremely useful for encouraging and monitoring progress.	• Students are tracked informally in class and in help sessions. • A staged submission monitors whether students are heading in the right direction. • Monitoring logins to systems is unreliable as one student may take the lead in logging in to retrieve or upload data. • Confidence logs and other questionnaire approaches are useful here.
10	**Marks and feedback** IT systems (such as ELP) can be used to receive submissions in a standard format and aid efficient marking. Feedback is given to students in both performance against the assessment criteria as well as more ad-hoc observations of their work.	• Students submit by deadline. Rules on late submissions may vary by country. • Students get prompt feedback due to standardised format of upload in learning system. • Peer assessment is essential to motivate and reward individuals.
11	**Teaching evaluation** Evaluation is essential and many tools can be used. Tracking of students (e. g. using confidence logs) enables understanding of the impact of applying the case approach early on. End of module questionnaires for overall teaching quality as well as assignment specific evaluation can give objective, retrospective evaluation.	• University level as well as lecturer devised evaluation is important to understand the impact on overall teaching quality and perceptions. • Collective student performance is monitored and compared with other concurrent teaching to understand performance variation and reasons for them.
(12)	**On-going lectures** The assignment runs in tandem with the lecture series. The mechanism of delivery is independent of the assignment and this can be a combination of structuring lectures and open learning approach.	• Throughout the module lectures are held to provide structure and detail of theories to be assessed. • Links are made throughout between the lecture material and the assignment.

The staff noted that, with the relationship between the institutions established, the assignment was straightforward to initiate and manage the second time and that will continue. For the students there is still wide variation in the speed at which student groups form and gel and this is an area that needs work to make more effective. The students to date have been excited and eager to engage in this type of collaboration where they meet other students in a unique set up. Whilst students are increasingly IT literate there is still the need to make the technology that supports their inter-institution communication as seamless as possible in the widest sense, from planning through to exchanging information through to decision making.

Future work will look at how short-term teamwork can be more effective and how students from other universities can be included. In particular, working in a multi-university collaboration where culture and language differences are more pronounced, as in working with universities in Mexico and China.

The approach and its evaluation have been presented and this was used to develop a model with supporting guidelines on how an international team assignment can be developed and implemented to enhance student experience and learning.

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