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Where to Locate? A Project-Based Learning Activity that Combines the Development of Technical and Soft Skills

Location decisions represent an integral part of the strategic planning process of firms. Because these decisions do have a significant impact on the organisation, location analysis is a recurrent topic in operations management courses.

In this study we posit that students enrolled in such courses should experience in an active way location decisions. To this end, this paper proposes an activity that, by adopting a student-centred approach, allows students getting involved in location decisions (technical skill) while simultaneously helps them boosting some of the soft skills that operation managers should possess (teamwork and use of new technologies). By mimicking a real life situation, students are asked to decide where to locate a specific new public service in the city of Barcelona.

This activity was part of a course on Operations Management, included in the Master's Degree in Engineering Management and Production Systems taught at Universitat Internacional de Catalunya (Barcelona, Spain).

Keywords: project-based learning; technical skills; soft skills; operations management; engineering education; location

Introduction

The pedagogic culture that supports the foundation of the European Higher Education Area (EHEA) has generated a paradigm shift in training education, urged by what industry expects higher education institutions should provide: subject-specific knowledge and the adequate skills and attitudes. In this sense, organisations expect from the higher education system to supply lifelong learning [1,2]. Students are also required to command new scientific ideas, be able to identify and solve problems, think and express their thoughts critically and develop team working capabilities [3]. All these demands presuppose significant changes in the traditional way universities operate, affecting not only faculty members in their capacity to act as education-drivers and designers of all learning, but also students, who are the active recipients of learning [4,5]. To respond to all those challenges, universities have adapted in a number of ways: moving from traditional passive teaching methodologies towards active student-centred learning [6]; helping students acquire transversal skills; encouraging project-based activities and increasing team cooperation that deploys creativity and social skills [7].

The present study proposes an active learning method in the form of a project-based activity to enhance both soft and technical skills among students. Soft skills, frequently called also generic or social skills, include those skills such as teamwork, presentation skills, commitment or leadership. In contrast, hard skills are specific technical skills that concern a certain field of knowledge.

This activity was part of a course on Operations Management taught in the Master's Degree in Engineering Management and Production Systems offered at Universitat Internacional de Catalunya, Spain. Students of the master's degree have either an engineering or a management background. The activity presents to students a location problem.

Location decisions represent an integral part of the strategic planning process of any organisation. Organisations become involved in location decisions for a variety of reasons. A typical location decision involves both qualitative and quantitative inputs, and these tend to vary from situation to situation depending on the particular needs. For instance, adding a new location to an existing system due to an expansion of the market; moving to another location because of a growth in the demand that cannot be satisfied by expanding at the

current location; or relocating to another place as a result of depletion of basic inputs at a given location or due to a market change, etc.

Because location decisions have a significant impact on the organisation and many factors influence and interact in this process, location analysis is a recurrent topic in operation management courses and alike programs.

In this study we posit that students enrolled in such courses should experience in an active way the importance of location analysis. To do this so, this paper describes a teamwork activity that, by adopting a student-centred approach and the use of new technologies, allows students to get involved in location decisions, mimicking a real life situation in which a management team should decide where to locate a specific new public service in a given city.

Students presented high quality projects where techniques and methodologies explained in the theoretical lesson were applied and new knowledge about location decisions was acquired through the process. Students' satisfaction was gathered and the surveys indicate that they positively evaluate this activity.

The paper is structured as follows: first a brief description of both the soft and hard skills that the activity intends to develop is presented. Second, the teaching methodology is explained. Then, the activity is described in detail and finally the paper closes stating the results and the conclusions.

1. Skill development

One of the pillars of the EHEA is the development of soft skills that students should acquire during their training at universities that are indispensable to satisfy industry's demands. In order to prepare learners for the labour market, higher education should provide them soft skills than can be transferred to other fields, such as the ability to cooperate, communicate or solve problems [1,8].

Soft skills are not as easily taught as hard skills, although they are very much needed too [9]. Over the last years the interest for soft skills in high education programs has suffered a significant growth. In engineering related disciplines, the main focus has been given to topics such as presentation skills, effective report writing, use of new technologies, teamwork and project management [10]. For the purpose of this study, the activity designed concentrates on two of the above mentioned soft skills: teamwork and use of new technologies.

Teamwork itself is considered one of the essential skills that should be provided by universities as an industry requirement, especially for engineers [11,12]. When learning with others, students are likely to learn more than alone because of the process of achieving a shared understanding and development of the project [13]. Given the diversity of experiences and backgrounds of the team members, it is of utmost importance a clear division of tasks and a continuous dialogue, coordination, negotiation and cooperation, in order to reach a common goal [7,9,14,15]. In this way, teamwork becomes a positive learning experience that enables the team to achieve better results than working alone [16]. Collaboration among students provide them opportunities to talk, sharing ideas and knowledge, asking and answering questions, and thus to extend their thinking and understanding [3,13,17]. Furthermore, the collaboration and transmission of knowledge that characterise the teamwork development can also be strengthened by a computer-aid training [11,13].

Concerning the use of new technologies, it is possible to find calls from the European Commission to boost and make a better use of the new technologies in higher education. Technology enhanced learning is proven to improve technological skills of students [18,19]. For the purpose of this activity, the use of new technologies is linked with the ability to find adequate information for the development of a project. According to Blumenfeld et al. [20] students acquire knowledge and skills by using a technological support (e.g. the Internet). In this case, the main goal is not to learn the technology itself, but to use it in a smart and effective way [21]. In addition, the use of the technology can contribute to sustain students' motivation and enhance their creativity by improving their interest and making a large volume of information accessible [22,23]. Moreover, it facilitates teamwork and peer interaction as long as knowledge sharing [16]. The use of computing and communication technologies in the development of a project makes the environment more real for the students [3], since they acquire the ability for finding and selecting information that is a basic requirement in the labour market. Thereby, Internet can serve as a link to the world outside the class breaking the barriers of space and time [11,24].

Due to all of the above, technology enhanced learning has changed the way universities provide education, lecturers teach and students learn [25]. Ruizacárate Varela et al. [11] recommend combining both online and traditional learning in order to achieve better results in problem solving and students' motivation.

The objective of the proposed activity is not confined to the development of soft skills such as teamwork and use of new technologies, but it also encompasses the development of hard skills. Technical skills are not

only necessary but also expected by employers. Students need to finish their degree with a high level of technical and specific skills that makes them competent and able to solve technical challenges [26].

For the case under analysis, we consider those technical skills related with the location problem, also known as location analysis or facility location problem. Specifically, the location problem is a branch of operations research concerned with the optimal placement of facilities to minimise transportation costs while considering other more qualitative factors like avoiding placing hazardous materials near housing. It is a complex problem that involves the evaluation and analysis of quantitative and qualitative information, prioritisation and decision-making.

2. Teaching method

The demand for new teaching methods that facilitate skill development while ensuring the acquisition of basic knowledge (theories and methods that form the basis of science) presupposes important changes in the traditional role of university lecturers and the preparation of teaching material. Indeed, the quality and usefulness of educational practices is the key for 'producing' highly skilled, competent and successful professionals. Recent studies addressing this need support the interest for this topic [27–30]. Pedagogy based on the development of skills provides students a lifelong learning, since they acquire generic skills through practice and formative assessment [31].

Active learning consists of having students engaged in the learning process: doing activities and thinking about what they are doing, reflecting their ideas and how they are using those [32,33]. Students "learn by doing", they acquire and retain knowledge by applying it while they participate or contribute in activities, improving their performance not only during the activity, but also after it [13,34]. Active learning places the learners in the centre of the process making them more independent and responsible. At the same time, educators change their role becoming guides, tutors or facilitators instead of expert authorities [21,24]. In general terms, traditional learning can be considered as the one that teaches fundamental theory and provides exercises for 'knowing-what', while active learning focuses on guiding students to develop a 'knowing-why' point of view [15]. Following Kirschner [5] and Prince [33], a balance between active and traditional learning is the best option, promoting learners engagement and including activities with disciplinary and interdisciplinary objectives into the lecture. Lecturers need to develop activities where students can apply the concepts learned in class, combining in this way the subject-specific and the transferable knowledge that the industry demands. If an active learning strategy is correctly implemented, it can provide students a higher motivation to learn, a longer retention of knowledge, a deeper understanding of the subject and positive attitudes [13].

According to Pulko and Parikh [10], in engineering education soft skills develop through engineering courses, but more specifically during project work. In this way, the emphasis on the content and the teaching methodology in universities with engineering programs have to shift from being focused on 'content' to pay attention also to 'process' [31]. It is important to encourage students not only to be able to select the skills that they need for completing a task, but also to learn the context where these skills can be applied in the work environment [7]. In this context is where project-based methodology plays a key role. According to Friedman [35], project-based learning is one of the most relevant active learning methods. It can be defined as a comprehensive perspective designed to engage students in investigation to solve real problems by using multiple cognitive instruments and various sources of information, while working in a social context. Since project-based learning encourages students to find solutions for problems in an authentic situation, it can serve as a link between classroom experiences and real-life events [22].

Within engineering education, previous studies reveal that, compared to the use of conventional approaches, the introduction of project-based activities increases instructor-student and student-student interactions, and enhances not only students' knowledge acquisition [36,37] but also the development of teamwork and communication skills [38]. In this field, some studies concluded that project-based learning seems to be more effective than the traditional lectures [24,39]. In general terms, project-based learning is shown to be a motivational tool that can increase students' interest through involving them in solving real problems, working in teams and finding authentic solutions. Lecturers emerge as a key figure in the design of project-based activities, since they are responsible for motivating the students through the selection of interesting projects with attainable resolutions, taking into account students' previous knowledge and their available means [22]. In order to succeed in the project development, students need to organise and do the assigned work, they need to collaborate with others and follow the tutor's indications, they have to collect and manage information, and they need to communicate and debate their ideas and findings [40]. In doing so, they acquire an invaluable experience that improves their autonomy and responsibility for their learning [41] and provides them with a sense of pride because of the accomplishment of the designed task [42].

3. Description of the project

4.1 Main purpose

Adopting a student-centred approach students were asked to get involved in a location decision mimicking a real life situation in which a manager should decide where to locate a new outlet for a specific public service (e.g. an official language school, a library, a youth hostel) in the city of Barcelona. To do this, students were expected to work in groups and make use of the new technologies (as a way to obtain information) in order to find the optimal solution. A project activity is thus designed in such a way that both technical (location decisions) and soft (teamwork and use of new technologies) skills can be simultaneously enhanced.

4.2 Sample

This project is part of a course on Operations Management taught in the Master's Degree in Engineering Management and Production Systems offered at Universitat Internacional de Catalunya. The activity was hold in November 2014, with a class size of 24 students. Students worked in groups of 4 members. Master students that participated in this course came from different countries and had different educational backgrounds, mainly in the areas of management and engineering. In order to enhance the discussion and allow the analysis from multiple perspectives, students with heterogeneous profiles were grouped together. Also, because this project required some knowledge about the city of Barcelona, each group contained at least one local student.

4.3 Detailed description

Location decisions use to follow a two-step decision process [43]: first, the selection of the region; second, the choice of the exact site within the region. Aiming at reproducing a real situation this activity also considers these two levels of decision making. Therefore, for the case under study, in a first level of decision students are asked to select the district of Barcelona where to locate the new outlet, and in a second-decision level, determine the precise location (e.g. street name and number).

Table 1 shows the different sub-tasks in which the project is organised. Throughout the whole activity the lecturer acts as a facilitator and drives students to reach a final solution. When starting the activity, the lecturer introduces the problem statement and explains to the whole class not only the academic requirements of the work to be delivered at the end of the activity, but also the methodology they should follow. A final presentation is scheduled at the end of this activity where each group orally presents their project and explains how they reached a solution. In addition, students are also told that after finishing the project they will be asked to answer a survey in order to capture their feedback and impressions of the usefulness and design of the activity.

Once all the instructions are given, students are organised in groups of 4, with the professor making some recommendations on how to group. First, as previously explained, each group should have, at least, one local student. Second, it is preferable to encourage students to put together with students with whom they do not use to work. In real life situations professionals do not use to choose who is going to be part of their team. Therefore, we recommend stimulating students to work with "unfamiliar" classmates.

Insert Table 1 about here

As shown in Table 1, the activity considers several milestones that act as check points (M1, M2 and M3), with an expected length no longer than 10 minutes per group. During this time, each group explains to the professor the early ideas emerging from the team discussion meetings (TD1, TD2 and TD3). While the professor is working with a team, the other groups move forward in the project.

The first team discussion (TD1) is about familiarising with the project topic. Students should examine the need for a new outlet for the service and determine who the target audience is. Searches in specific websites informing about the current provision of the service are expected. Next, team discussion 2 (TD2) consists of determining in which district the new outlet would best complement (and not overlap) the existing ones. To do this so, students are encouraged to generate a list with the most influential factors. For instance, if a new youth hostel is to be opened, it would make sense to account, among others aspects, for the number of top tourist sites, transportation facilities or the entertainment offer in the district. For each criterion a grading scale should be then suggested, so that it is possible to determine how each district is performing in each of the standards chosen. Later, factors are weighted according to their degree of importance regarding the service, and each district

obtains an overall score. At this step students heavily rely on the statistics that are publicly available through the website of the city town hall and the specific websites of the public service.

Once the district is selected, a second assessment procedure is needed in order to decide the exact location of the new outlet (TD3). This third step might combine the use of qualitative and quantitative approaches. One the one hand, by following a similar procedure as in TD2, qualitative approaches can be used to rank districts and reduce the number of potential emplacements. Only when two or three potential sites remain, quantitative techniques (e.g. the rectangular distance, the Euclidean distance, the centre of gravity, isocost curves) can be used to reach the final solution. This final location should be given in terms of the name of the street and street number. It will be positively valued if the emplacement is a feasible solution. As for the use of new technologies, in this stage students are found to browse on the internet for different real estate websites, and use Google Maps to calculate distances.

At this point it is worth mentioning the usefulness of factor rating as an approach to evaluate and compare location alternatives. Factor rating enables decision makers (in our case, students) to incorporate their personal opinion as well as quantitative information into the decision process, mixing qualitative and quantitative data. By establishing a composite value for each alternative that summarises all related factors it is possible to rank alternatives and chose a final emplacement.

During the whole project the lecturer adopts a facilitator role, assisting students when needed, and ensuring that the project will reach an end within the given time. It is important to note that prior to starting with the activity students have only been working on location decisions for two hours, where a general introduction was given and several examples were discussed.

4. Results

Results were evaluated in terms of academic performance and student satisfaction. As for the academic results, grades were given based on the final report and the oral presentation. A rubric for the oral presentation was designed so that students exactly knew how they were going to be evaluated (see Table 2). Both the reports and the presentations were of high quality, using appropriate factors and clearly justifying every decision.

24 students were grouped into 6 groups, each one focusing on a specific public service. Two of these groups obtained the highest score (10), three groups were graded with a 9, and one group obtained an 8.5.

Insert Table 2 about here

Regarding students' feedback, a survey was designed aiming at capturing their impressions. Questions included in the survey with their average scores are displayed in Table 2. Each item was evaluated according to a 5-point Likert scale, where 1 indicates "completely disagree" and 5 "completely agree".

Insert Table 3 about here

From the results it can be interfered that what students valued most was the methodology chosen. They appreciate this activity to be attractive and interesting, and that it facilitates understanding the main concepts related with location decisions. The support of the lecturer was also key to ensure the success of the activity. Therefore we can conclude, that all in all, the experience resulted in encouraging results which demonstrate that traditional lecturing methods should be complemented with more active-oriented activities, where students are placed at the centre of the learning process.

5. Conclusions

In this article we have reported the results obtained in a project-based learning activity on location analysis. Results emerging from this first edition of this activity are promising, both in terms of the quality of the work and students' satisfaction.

We believe that practical experiences such as the one suggested here should be further designed and implemented in operations management courses. Several are the advantages. First, by simulating real life

situations and using a student-centred approach (project-based learning), it is possible to actively involve all students. Moreover, by working on the project, they do not only find a solution, but also put in practice their knowledge. In addition, by conducting this activity several soft skills are also expected to be boosted. In our case, emphasis is placed on two of them: the ability to find information through the use of new technologies and teamwork. This activity also creates an open and transparent atmosphere where goals are clearly settled and students have to actively cooperate rather than compete to reach a solution. In this respect, an individual's learning success or failure is linked with the results of the other group members. Indeed, this situation is very similar to the one that future graduates will find in a firm environment.

This was the first edition of this type of activity in the Operations Management course at a Masters' level in the Universitat Internacional de Catalunya. As the first edition, the lecturer observed several opportunities of improvement and ways to expand the scope of the project. The activity can be expanded to include more students. In this regard, it is important to note that one of the key factors that helped the activity to be highly effective was the small size of the working groups and the continuous attention, dedication and counselling each of the groups got from the lecturer in charge of the activity. This would not have been possible with groups bigger than 20-30 students. In those cases, two facilitators would be necessary.

The project can also be expanded by incorporating into the objectives of the activity the development of other soft skills such as critical thinking. Critical thinking could be incorporated by developing a peer-to-peer evaluation system where participants in the activity evaluate and comment on other groups' work.

Another way to broaden the scope of the activity could be to include into the activity learning from other areas of knowledge making the project interdisciplinary. For example, students could be required to include the cost evaluation of the project which would force students to incorporate knowledge from other disciplines such as accounting and finance.

The project was designed using real information from a particular city, in this case Barcelona, Spain. The idea was to put students in a situation as close to reality as possible. This purpose could be enhanced by bringing into the class professionals (for example responsible for services' locations in the city hall) that could explain first-hand what the problems they face are and that evaluate the resulting projects at the end of the activity. Obviously all those enlargements of the activity would probably require a revision of the time allocated to it.

In sum, the activity proposed is a project based on real data that inspires students as well as promotes the development of soft and hard skills. The activity offers multiple possibilities to adapt it to other environments, number of students or learning objectives. We believe that there is the need for adopting similar experiences in other more traditional master courses.

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Table 1. Detailed description of the activity

Order	Sub-task	Duration
1	The lecturer introduces the project and describes the rules	20 min
2	Group formation and distribution of the public services to be located	5 min
3	Team discussion (TD1): Familiarisation with the service. Initial brainstorming	40 min
4	First milestone (M1)	10 min/group
5	Team discussion (TD2): Decide the weights and criteria that would allow choosing the district. Assign weights indicating the relative importance of each factor compared to all others, and establish a scale for each factor	1 hour
6	Second milestone (M2)	10 min/group
7	Team discussion (TD3): Define the factors that are relevant for selecting the exact place to locate, assign weights, and decide a common scale for all factors	1 hour
8	Third milestone (M3)	10 min/group
9	Elaboration of the final report	1 hour
10	Oral presentation	10 min/group

Table 2. Rubric for the oral presentation (scale 4 to 1)

Criteria		Superior (4)	Adequate (3)	Minimal (2)	Inadequate (1)
Content	Structure	The presentation is organised as follows: initial considerations of the service to be located, current provision, first-level analysis (criteria and weights), second-level analysis (criteria and weights), final decision, conclusions.	The presentation omits one of the required sections (initial considerations of the service to be located, current provision, first-level analysis, second-level analysis, final decision, conclusions), or uses a different order.	The presentation is incomplete, omitting important sections (initial considerations of the service to be located, current provision, first-level analysis, second-level analysis, final decision, conclusions), or uses a different order.	The presentation is structured in a chaotic way, and the required sections (initial considerations of the service to be located, current provision, first-level analysis, second-level analysis, final decision, conclusions), are not clear at all.
	Organisation	The presentation is overtly organised. The ideas in the message can be easily outlined.	The message is organised.	The organisation of the message is mixed up and random. The listener must make some assumptions about the sequence and relationship of ideas.	The message is so disorganised you cannot understand most of the message.
Comprehension	Subject knowledge	Students demonstrate full knowledge by answering all class questions with explanations and elaboration.	Students are at ease with expected answers to all questions, but fail to elaborate.	Students are uncomfortable with information and are able to answer only rudimentary questions.	Students do not have grasp of information and are unable to accurately answer the questions.
Style	Creativity	Very original presentation of material; captures the audience's attention.	Some originality apparent; good variety and blending of materials / media.	Little or no variation; material presented with little originality or interpretation.	Repetitive with little or no variety; insufficient use of materials / media.
	Text - Font Choice & Formatting	Font formats (e.g., colour, bold, italic) have been carefully planned to enhance readability and content.	Font formats have been carefully planned to enhance readability.	Font formatting has been carefully planned to complement the content. It may be a little hard to read.	Font formatting makes it very difficult to read the material.
	Length of Presentation	Within two minutes of allotted time.	Within four minutes of allotted time.	Within five minutes of allotted time.	Too long or too short; six or more minutes above or below the allotted time.

Table 3. Students' feedback (scale 1 to 5)

Activity	**Average score**
LEARNING	3.70
I learnt things that I consider to be valuable	3.69
I have learnt and understood the module on location decisions	3.77
The activity has contributed to improve my understanding of the subject	3.65
METHODOLOGY	4.23
The activity was intellectually engaging and stimulating	4.32
The lecturer gave clear explanations	4.15
Students were encouraged to discuss and exchange their ideas	4.08
The lecturer was approachable in individual dealings with groups	4.35