LEARNING STATISTICAL CAPACITY CONCEPT THROUGH AN EXPERIENTIAL LEARNING ACTIVITY

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Abstract

This paper describes the application of an experiential learning activity to demonstrate and apply statistical concepts widely applied in the industry. The learning objectives of this activity are to know, describe and represent the different indicators related to Process and Product Capacity. In addition, we are looking for higher levels of learning by interpreting the measures and assessing them. We simulated a real situation of the industry adapted to a learning context which application will be reflecting the production and subsequent quality control of a process. The way in which learning is carried out is a substantial change over traditional methodology. The activity approach to learning is inductive and it is based on previous knowledge within the same subject. It establishes a connection between the objectives and the directed activities, so that the students, in a fun and relaxed way, become aware of the knowledge they are acquiring and its practical usefulness in real life.

Keywords: Experiential Learning Activity, Statistical capacity, Process capacity.

1 INTRODUCTION

The teaching-learning process is a complex task that involves many factors that are widely interrelated. The existence of learning objectives determines the content to be taught, and, in many cases, the methodology. On the one hand, the instructor must meet the objectives and the timeline set for the course. On the other hand, the student must acquire the sufficient knowledge and skills through the course assessments. In addition, there are other factors unrelated to the instructor, such as background knowledge, student’s work load, student’s commitment, etc.

Traditionally, the teaching-learning process has been focused on achieving the instructor’s goals. The instructor transfers knowledge to students through a master class and students should concentrate their efforts on understanding the concepts and memorizing the procedures. New trends are far away from this approach and put the student on the centre of the teaching-learning process.

One of the new approaches is based on Experiential Learning Activities (ELA). In this methodology, the instructor becomes a facilitator of the student learning, guiding the student to acquire the concepts and skills through experimentation.

Additionally, students motivation plays today a key role in the class sessions. Traditional methods base all the motivation on external agents, while ELA encourages internal motivation by the students involvement in the experiences. This methodology turns out to be much more efficient for the acquisition of knowledge [1]. Indeed, it builds on attitudinal aspects such as, critical thinking, group work, communication skills, leadership etc., which are attitudes that add a not insignificant value to the students.

The main disadvantage of the development of ELAs is the complexity of the implementation. Activities should be clear from the outset, as well as the evaluation methods or how to manage the development of the activity. However, the results show a great improvement in the achievement of the learning objectives.

The aim of this paper is to propose a new Experiential Learning Activity (ELA) to teach process capability, which is a statistical concept used in different courses, such as, Operations Management or Quality Control. The experience is based on a real industrial process, in which the students must make the decision of which tools to use to be able to fulfill the specifications of the client. The structure of the activity is divided into different phases according to LaForge and Busing [2]. This activity will propose a series of situations, reflecting real situations in the industry, in which the students will have
to face a process of decision-making based on statistical procedures. This process allows the student achieve meaningful learning through reflective observation of his performance during the activity [3,4].

2 METHODOLOGY

2.1 Procedure

The instructor puts on the tables the different tools and materials necessary to carry out the practice. It is important to emphasize that the instructor must perform this task before the students enter in the classroom, in order to provoke the student's interest in the activity.

Students are arranged in groups randomly. The number of groups should be organized according to the number of participants, but we recommend groups not less than 4 and more than 6 students.

The instructor will explain the fundamentals to be addressed and the tasks to be performed by the students.

Experiential learning activity begins with sampling. At least 30 samples are required in each group, so the components of each group should alternate in the tasks. All members of the group must perform the tasks of cutting, measuring and sampling. The amount of samples for each member of the group must be more or less the same, adding up to 30 units.

To perform the tasks, each group will have different cards of one color. The color will be different for each group. The task is to cut or drill the cards, according to a common pattern. The pattern consists of a metallic template that will be used to draw the cutting pattern on the cardboard with a pen.

The tool used to make the cut will be different in each group: scissors, cutter, a cutter and a guide and a crown drill. If more groups are available, these tools can be repeated or new ones introduced. Figure 1 shows a sample of the tools used in the sessions.

![Figure 1. Tools used in this practice: scissors, a cutter and crowns. Tools to aid in the cutting process are also available.](image)

The students must measure the diameters obtained after the cuts. It is important to provide a standardized methodology for data collection. Therefore, we provide the students with a transparent template with millimeter trace to measure the deviations obtained between the nominal measure and the samples made by the students. We propose a template as shown in Figure 2.

![Figure 2. Cut check template in millimeters.](image)
Students place the template on the theoretical center of the circumference and measure the relative value of the deviation. The template has 10 divisions where to make the measurements. In order to organize the data in a standardized way, we provide the students with a response sheet template (see Figure 3). This template includes the data of interest for the study, such as, the tool used, part specifications and the deviations. In addition, the template provides an area to analyze normality and to study the parameters of the distribution, which are concepts previously treated in other sessions and necessary for the understanding of this activity.

Data analysis is done with the help of statistical software, such as R, SPSS, Statgraphics. The use of software contributes to student’s motivation and reinforces previous statistical knowledge from other sessions as well.

2.2 Activity summary and debate

The discussion begins by obtaining the distributions of the measurements made, and evaluating the deviations obtained with each of the manufacturing and measurement processes. The position parameters (mean and median) and the dispersion values (range) will be obtained, as well as the standard deviation of the population and the sample. If statistical software is available, it is also possible to obtain the interquartile ranges, Box-Whiskers diagrams. The results are compared among different groups, and a debate is established on the processes used and if they are adequate to carry out this activity.

In the debate, certain questions must be raised to help understand industrial processes and relate them to the activity. The instructors might encourage debate by asking questions such as: Which process produces less dispersion?, Which of the processes gets the measures more centered?, Did the data we obtained follow a normal distribution? or What variables are affecting the process?

Subsequently, a tolerance specification is introduced, so that the parts made must meet these specifications. At this moment, the each group of students must calculate the dimensional and geometric tolerances, and compare them with other processes used. Capacity indexes are used to determine the suitability of processes. Using economic data on the cost of labor, materials and tools, it is also possible to assess the cost of non-quality motivated by not meeting the specifications.

During this part of the analysis, the instructor should promote discussions among the members of the groups with questions such as: why is it necessary to have limits on specifications?, how much do they need to be met?, what would happen if we exceeded the upper limit of specification?, what happens if we exceed the lower limit? or what is the economic cost of not meeting specifications?
Finally, a series of products with their specifications are proposed at the general level, so each group must establish a process for each of them, taking into account the capacities calculated previously. At the end of this ELA, students should know the indicators used and their relationship to the specifications, as well as the statistical processes used to determine the characteristics of production. They should also be able to recognize the influence of using this tool in industrial processes and determine the cost of non-quality associated with a breach of customer specifications.

The activity ends with a small master class by the instructor remarking all the concepts experienced and the procedures used during the activity. This way of structuring the lesson will allow students to achieve higher levels of learning [5–7].

3 RESULTS

The evaluation of the result of the activity is a fundamental part to determine the success of the proposed activity. As it is an experiential activity, it is not only important to determine the acquisition of the concepts, but also an evaluation of the transversal aspects of the activity, such as, motivation or applicability to real industrial situation, should be included. For this purpose, an evaluation of results has been designed to be carried out at the end of the activity. We evaluated the activity using a survey with a Likert 1 to 5 scale, where 1 corresponds to totally disagree and 5 to totally agree. The concepts must be treated on the one hand and transversal skills on the other. Thus, the instructor can gather information and feedback about the impact of the exercise to improve the activity in the future. Table 1 shows the questionnaire and results used for the assessment.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did the activity helped the team to learn how to retrieve the data needed to calculate the Process Capacity?</td>
<td>4,77</td>
</tr>
<tr>
<td>Did the activity helped the team to learn how a process affects variability of the product you produced?</td>
<td>4,57</td>
</tr>
<tr>
<td>Did the activity helped the team to detect when if the process is good enough to meet specifications?</td>
<td>4,66</td>
</tr>
<tr>
<td>Did the activity helped the team to detect other processes better/worse to meet customers specifications?</td>
<td>4,86</td>
</tr>
<tr>
<td>To which extent do you think that you could carry out the calculation of the capacity of a process by yourself from what has been learned in the experience?</td>
<td>4,14</td>
</tr>
<tr>
<td>To which extent has the experience been preferable and motivating over a master class</td>
<td>4,91</td>
</tr>
<tr>
<td>Do you think the activity helped the group to act as a team?</td>
<td>4,77</td>
</tr>
<tr>
<td>To which extent has communication been important in solving the activity?</td>
<td>4,09</td>
</tr>
<tr>
<td>To which extent have you been able to participate and express your opinions in the group discussion and in the general discussion?</td>
<td>4,51</td>
</tr>
<tr>
<td>Would you recommend the experience to learn about Process Capacity topics?</td>
<td>4,94</td>
</tr>
</tbody>
</table>

Although, these are preliminary results are based on an experience over 35 students, the results indicate that the activity establishes a connection between the objectives and the directed activities, so that the students, in a motivating way, become aware of the knowledge they are acquiring and its practical usefulness in real life.

4 CONCLUSIONS

This article provides an Experiential Learning Activity designed to acquire the necessary concepts about process and product capability. This activity is designed based on the motivation and interest of the student while acquiring the new knowledge. This activity simulates a real decision-making process based on the concept of capacity. In this way, more meaningful learning is achieved.
The article also deals with concepts of variability, specifications, and relationships between them. The analysis and evaluation of the results are also discussed. On the other hand, we demonstrate the possibilities offered by experiential activities in the motivation of students, while at the same time allowing for instruction of complex concepts that are difficult to deliver by traditional methods and complicated to relate to industrial processes.

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REFERENCES


