

APPLYING THE LEARNING EFFECT THROUGH A CLASSROOM MANUFACTURING SIMULATION

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Abstract

Understanding the learning effect and the learning curve is a central component of Operations Management courses, yet these concepts are often taught through simplified numerical exercises. Reproducing a manufacturing process in the classroom allows students to directly experience and analyse their own learning process.

This poster presents a classroom-based activity developed in the Operations Management I course, in which students worked in pairs to simulate a simple production process by manufacturing paper helicopters. Through task repetition, students were able to observe the learning effect and analyse how performance improves with experience. In addition, the activity introduced a specific operational variable related to the tools used, comparing the use of small scissors and large scissors, in order to assess how tool selection influences learning speeds and productivity.

The results show that students empirically verified the learning effect and the evolution of the learning curve, as well as identified differences in performance depending on the tools used. In fact, the results show an asymmetry: while tool wear, as expected, hinders learning, improvements in the tools do not lead to better learning. The activity encouraged active participation, critical reflection and a deeper understanding of key Operations Management concepts, such as efficiency and productivity.

This experience demonstrates that simple and low-cost manufacturing simulations are effective teaching tools for illustrating the learning effect practical sessions in Operations Management courses.

Keywords: *Learning effect, learning curve, operations management, experiential learning, teaching innovation.*

1. Introduction

Understanding the learning effect and the learning curve is a core topic in Operations Management education, yet these concepts are frequently taught through simplified numerical exercises that limit students' ability to fully grasp their practical implications. The learning effect refers to performance improvements derived from accumulated experience, typically reflected in a reduction in unit production time as repetition increases (Grosse et al., 2015). This phenomenon is commonly represented through the learning curve, which describes a predictable decrease in time as cumulative output grows.

To address the limitations of purely theoretical approaches, this study proposes a classroom-based manufacturing simulation that allows students to directly experience their own learning process. By reproducing a simple production system, students can observe how performance evolves through repetition and how operational decisions influence learning dynamics. In particular, this activity introduces tool selection as an experimental variable, enabling the analysis of how changes in production conditions affect productivity and learning rates.

This activity builds on previous classroom-based manufacturing simulations developed in Operations Management education (e.g. Tarifa et al., 2016; de Burgos et al., 2017; Frydenberg et al., 2018; Sánchez et al., 2023).

2. Objectives

The aim of this study is to improve students' understanding of the learning effect through an experiential learning activity embedded in an Operations Management course. Specifically, the activity seeks to enable students to observe performance improvements through repetition, compare predicted and

actual performance based on learning curve assumptions, and analyse the impact of tool selection on productivity and learning behaviours. At the same time, the activity is designed to promote active participation and critical reflection on key concepts such as efficiency, productivity and process improvement (Kolb, 1984).

3. Methods

The activity was conducted with 108 undergraduate students enrolled in an Operations Management course. Students participated individually in a simulated production process consisting of manufacturing paper helicopters from standardised templates.

A quasi-experimental crossover design was implemented. Students completed three production rounds of five minutes each. In the first two rounds, participants used the same tool (small or large scissors), allowing the observation of the learning effect through repetition. In the third round, they switched tools (small-to-large or large-to-small), enabling the analysis of how changes in operational conditions affect performance and learning.

After each round, students recorded the number of units produced and calculated unit production times. Based on the first two rounds, they estimated their learning rate using the number of units produced per time interval (Anzanello y Fogliatto, 2011), and then to predict their expected performance in the third round assuming no change in conditions. These predictions were then compared with actual results after the tool change. This design allowed both within-subject analysis (before vs. after tool change) and between-condition comparison (different tool sequences), providing a structured framework to analyse learning dynamics.

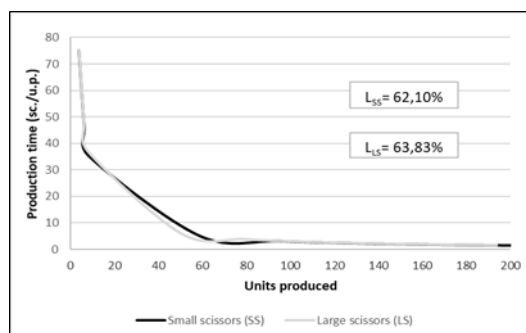
4. Results

The results show a clear and consistent learning effect (Figure 1). Approximately 97% of students improved their performance between the first and second rounds, with average production increasing from around 5 units to over 8 units, representing an improvement of nearly 60%. This confirms that manual repetitive tasks generate robust learning effects (Grosse et al., 2015).

The introduction of a tool change revealed asymmetric effects on learning. When students switched from large to small scissors, performance deteriorated in most cases, with over 80% showing a worsening in their learning rate (Figure 2). In contrast, switching from small to large scissors produced mixed and less consistent results, with similar proportions of students improving and worsening their performance.

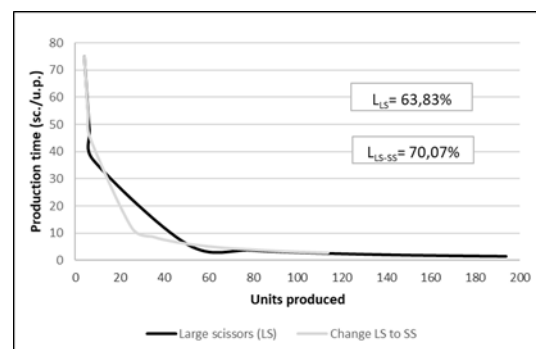
Students also observed systematic differences between predicted and actual performance. Predictions based on learning curve assumptions tended to overestimate output when tools changed, highlighting the sensitivity of learning processes to variations in operational conditions.

Figure 1. Learning curve of the SS group and the LS group.



Source: Own elaboration

Figure 2. LS→SS Group learning curve.



Source: Own elaboration

5. Discussion

The findings highlight the effectiveness of experiential learning approaches in teaching Operations Management concepts. By engaging in a simulated production process, students directly observe the learning effect and understand how performance improves through repetition (Kolb, 1984).

The introduction of tool variability demonstrates that learning is not solely driven by repetition but is also influenced by operational conditions. The asymmetric results suggest that deteriorations in tools have a stronger and more consistent negative impact than improvements have a positive one. This pattern can be interpreted in terms of adaptation effects and behavioural responses, where changes in tools disrupt established routines and require cognitive adjustment.

Furthermore, the differences between predicted and actual performance provide valuable pedagogical insights, encouraging students to critically evaluate the assumptions underlying learning curve models. This contributes to bridging the gap between theoretical models and real operational environments.

6. Conclusions

This study demonstrates that a simple classroom-based manufacturing simulation is an effective tool for teaching the learning effect and learning curves in higher education. The activity allows students to experience performance improvements directly, reinforcing theoretical concepts through practice and observation.

The results confirm that learning processes are influenced not only by repetition but also by changes in operational conditions. In particular, the asymmetric impact of tool changes highlights that performance deterioration is more pronounced and consistent than performance improvement, suggesting that learning dynamics are shaped by both ergonomic and behavioral factors.

From a pedagogical perspective, the activity promotes active participation, immediate feedback, and critical reflection. Its simplicity and low cost make it highly transferable and easy to implement in different educational contexts. The activity requires minimal materials (paper templates and scissors), can be completed in approximately 20–25 minutes, and follows a clear sequence of production rounds and performance analysis, supporting its replicability.

Despite its contributions, this study has some limitations. Learning rates were estimated using units produced per time interval (Anzanello y Fogliatto, 2011), which may reduce precision compared to cumulative models commonly used in Operations Management (Krajewski & Ritzman, 2000). Future research could incorporate more advanced estimation techniques and explore additional variables influencing learning processes, such as task complexity or user characteristics.

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