USE OF P-CHART IN TEACHING AND LEARNING FOR QUALITY IMPROVEMENT

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Abstract

Quality assurance in higher education greatly involves enhancing teaching and learning (TL) processes with the ultimate target of improving educational outcomes to the expected quality level. However, quality enhancement through a statistical process control (SPC) technique has not been deeply applied in educational institutes. Therefore, this study aims at developing a control chart for the proportion of "failed students' in the most critical course module in the curriculum. This analysis considered data relevant to the specific course module from the 2001 batch to the 2020 batch. The control limits of the p-chart developed using the controlled data points were used to monitor the TL process of the particular course and identify any significant deviation from the "in control" situation. Hence, the developed control chart can be used as an on-going process monitoring technique to modify and enhance the TL process of this course in order to meet the expected requirements.

Keywords: *Control Limits, p-chart, Quality Assurance, Statistical Process Control, Teaching and Learning*

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Introduction

In order to maintain and enhance the quality, equity, and efficiency of higher educational programs and processes, quality assurance involves a systematic review. (Perera & Hettiarachchi, 2014). Therefore, higher educational institutes are expected to establish and execute a proper quality management tool for continuous process monitoring. Various activities in teaching and learning (TL) such as peer reviewing, program reviewing, feedback evaluation, accreditation, and standardization are common practices to maintain the expected quality level of the process. Savic (2006) has indicated that the use of statistical control charts is a well-known and effective technique that has a role in the social sciences, particularly in the quality assurance of educational systems. Usually, a quality control chart is used in scientific research project management as well as in the management of products with ahigh level of quality. It allows for easy control analysis, identification of root causes, and management improvement. (Ying, 2015). However, educational institutes have scarcely applied the statistical process control (SPC) technique in this regard. (Hanna, Raichura, & Bernardes, 2012). Therefore, the main objective of this study is to construct a quality tool to enhance the TL processof a particular course module by considering the failure rate of batches that followed the module as critical to quality in the respective TL process.

Material and Methods

The most critical course module that greatly influences students' graduation was found by conducting a survey among the final year students in the faculty. The data from batch 2001 to batch 2020 were used in this study. Proportions of the 'failed students' of each batch were used to calculate the control limits of the control chart (P-Chart). Since the batch sizes were different, control limits vary by batch. Developing control charts was done using Minitab 17 and Microsoft Excel. After developing appropriate control limits (CLs), the presence of some special causes (which seriously affected students' performance) on the control charts could be identified by the data points that were beyond the control limits. Then the root causes of those points were investigated, and necessary action was taken to rectify the process. After repeating the same steps with the data, in which true unusual data points are excluded, the control limits of the p-chart were developed again. Until there are no data points plotted beyond the control limits, this process was repeated several times. Finally, the control chart with reliable control limits was developed and used for current TL process monitoring.

The effectiveness of the method was evaluated through ARL (Average Run

Length) curves. ARL measures the expected number of samples that should be taken before the out-of-control signal. (Montgomery, 2005). Since there isno option to draw ARL curves in Minitab, the respective ARL curve was developed using R statistical software.

Results and Discussion

The relevant outcome of the analysis was presented in this section.

Figure 1 shows the proportion of 'failed students' in the course. The highest proportion of failed students (5%) was indicated in the 7th and 11th batches (2007 and 2011). The one-sided p-chart developed for the original dataset is shown in Figure 2, and Figure 3 shows the control chart that was developed after removing the out-of-control data points. As indicated by Figure 1, the p-chart in Figure 2 shows out-of-control data points for the 7th and 11th batches.

Before developing the control chart indicated in Figure 3, an investigation was conducted for the 7th and 11th groups to find out the assignable causes. Poor student attendance at lectures and a lack of practical sessions were identified as reasons for this out of control process. Hence, 80% student attendance was made mandatory, and practical sessions for students were increased as solutions.

Figure 1:

Bar *chart of proportion of 'failed students'*

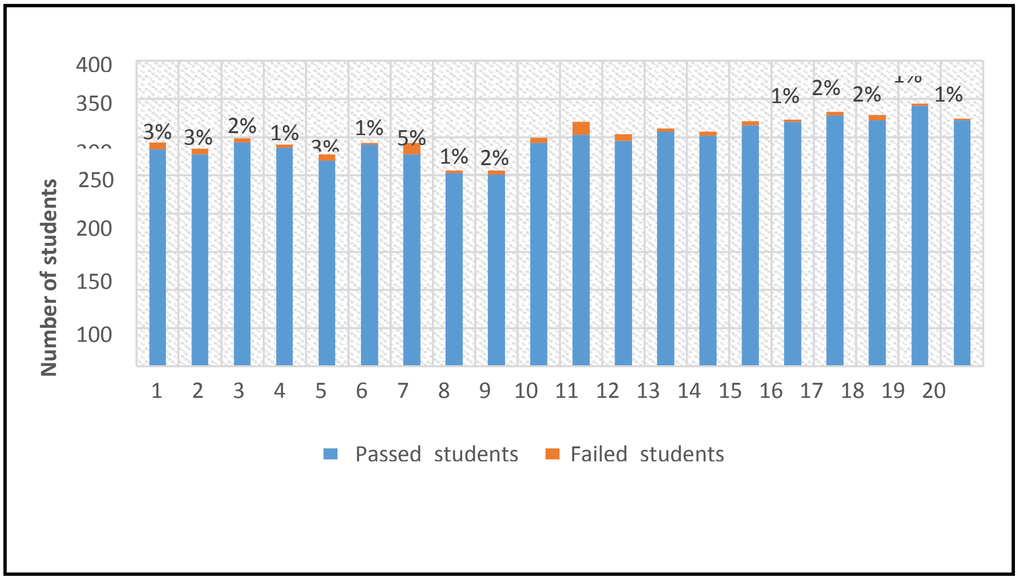


Figure 2:

P-chart of 'failed student' proportion (Original data)

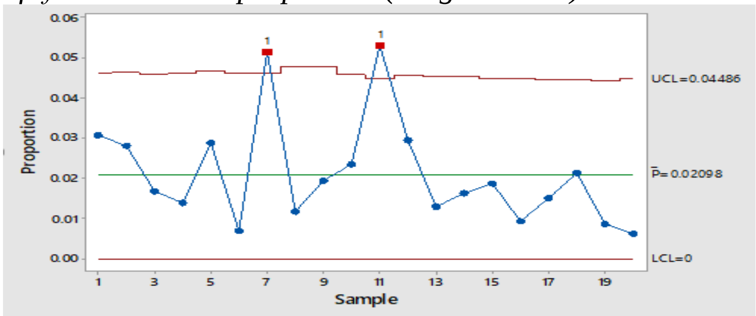
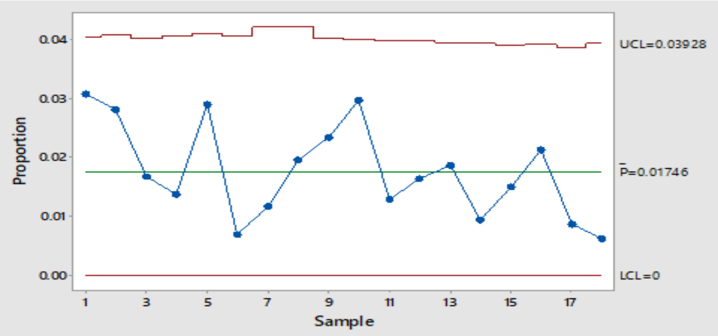


Figure 3:

P-chart of 'failed student' proportion (with reliable control limits)



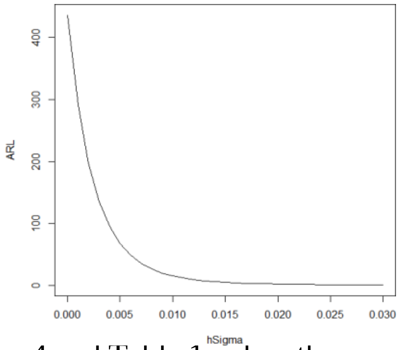
Reliable control limits, which were developed after removing the out-of-control data points were shown in Figure 3 and the control limits are varying and are based on the number of registered students (number of each sample size). Central Line (CL) is .017746 (1.77%) which means that on average, 1.77% of students failed.

The p-value for the proportion of failed students is 0.503 according to the Anderson-Darling Normality Test results. Therefore, it can be concluded that the proportion of failed students is normally distributed at a 5% level of significance. It secured the normality assumption that should be followed by the data used for the p-chart.

Figure 4 shows the ARL curve, generated to evaluate the statistical performance of the developed p control chart. It shows the ARL values in relation to different shifts (hsigma) of the process mean. Table 1 shows the ARL values for the control chart when an out-of-control signal is received at different shifts of the process mean.

Figure 4:

ARL curve of p-chart



According to Figure 4 and Table 1, when the process is in control (hSigma = 0), the expected number of samples (436) before getting the first out-of-control signal is very high. As a result, ARL values are significantly large for small shifts in the process mean. In contrast, ARL values get smaller when there are considerably large shifts. Therefore, it shows that the performance of the developed p-chart is highly reliable in detecting out-of-control situations.

Table 1:

ARL values of p-chart with respect to different shifts of the process mean

Size of shift	0 (No shift)	.002	.004	.006	.008	.01	.02	.03	.04
ARL	436	197	95	49	27	16	2	1	1

Conclusion and Recommendations

This article shows how we can use control charting techniques in the education sector to monitor and control TL activities. Further, it shows how a P chart asan effective SPC tool can be used as a continuous process monitoring technique to sustain an effective teaching and learning process for quality enhancement. However, since this study is simply an application of the p-chart to the education sector, it has limited the theoretical contribution, but as a practical implementation, this can be considered a remarkable solution to improve TL activities in educational institutes, which facilitates continuous process monitoring. The same procedure suggested in this study can be applied to the whole curriculum in order to implement the continuous enhancement ofthe academic performance of the institute.

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