Original Paper

European Journal of Digital Economy Research
2022 Vol.3 Issue.2 pp.53-58

PROCESS-ORIENTED PERFORMANCE ASSESSMENT OF ONLINE LEARNING DURING THE COVID-19 PANDEMIC

Hayrettin USUL*, Nuri ÖMÜRBEK, Mustafa Zihni TUNCA*****

* Prof. Dr., İzmir Kâtip Çelebi University, Faculty of Economics and Administrative Sciences, Business Administration, hayrettin.usul@ikc.edu.tr, https://orcid.org/0000-0002-3930-0866.

** Prof. Dr., Süleyman Demirel University, Faculty of Economics and Administrative Sciences, Business Administration, nuriomurbek@sdu.edu.tr, https://orcid.org/0000-0002-0360-4040.

*** Prof. Dr., Süleyman Demirel University, Faculty of Economics and Administrative Sciences, Business Administration, mustafatunca@sdu.edu.tr, https://orcid.org/0000-0003-2315-905X.

ABSTRACT

Lockdown and social distancing measures caused by the COVID-19 pandemic have led to focusing on online alternatives in education around the world. As a result, quick adoption necessity of new online learning facilities have led to several challenges to educators and students. Therefore, it is important to measure the quality and effectiveness of online education. The aim of this study is to exemplify the use of a process-oriented assessment tools for online education to improve the quality of learning process. Statistical process control (SPC) is one of the commonly accepted quality improvement approaches that utilizes quality control charts to inform decision-makers instantly to diagnose the origin of the problems. This paper demonstrates that SPC can be a functional tool to support the assessment of online learning. Hence, performance of the online students on weekly quiz questions in an undergraduate level accounting course has been monitored during the COVID-19 pandemic. Then, the C Control Chart has been drawn to investigate the performance of the students.

Keywords: *Online Learning, Process-Oriented Performance Assessment, Statistical Process Control, C Control Chart.*

1. INTRODUCTION

The COVID-19 pandemic has played an important role in the spread of remote working and distance learning practices (Szopiński & Bachnik, 2022). Successful e-learning adoption can be only achieved by the integration of modern education and information technologies (Qiu et al., 2022). Although in the last two decades, many higher education institutions started to adopted distance learning systems (Yeung & Yau, 2022), the COVID-19 pandemic has forced universities to immediately implement online learning activities, giving little time for educators and students to familiarize e-learning systems (Salas-Pilco et al., 2022).

Online education, which gained momentum with the COVID-19 pandemic, initially brought many challenges to both educators and students (Özcan, & Tunca 2021). One of the most prominent problems regarding online education is the quality and effectiveness (Szopiński & Bachnik, 2022). According to Hongsuchon et al. (2022), the effectiveness of online learning refers to "improving student's abilities via the learning process while using digital media and connecting online".

While some scholars argue that aspects of online learning experience differ from those of face-to-face teaching (Kim et al., 2022), some studies in the literature highlight that online learning outcomes of students have similarities to traditional face-to-face learning outcomes (Redpath, 2012). Krishnamurthy (2020), however, highlights that according to the suggestions of the previous studies in the literature, the performance of online students is better than students in traditional classroom environments.

In the literature, various approaches such as exam scores, student attitudes, and student satisfaction to assess the effectiveness of online learning in achieving learning outcomes (Robinson & Hullinger, 2008). Salas-Pilco et al. (2022) asserts that there still is a lack of studies in the literature that focus on the efficiency of the student engagement in online learning as majority of the previous studies solely focused on the students' engagement with digital technologies.

The objective of modern education is to improve the quality of learning experience by providing student-centered teaching methods. Such innovative teaching methods require new approaches to measure the performance of the education system by monitoring the outcomes. Therefore, in addition to traditional assessment methods, there are always increasing demand for alternative approaches (Wondimu, 2010).

Modern methods are particularly based on authentic measurement tools that allow reliable and accurate assessment of students existing knowledge and abilities. Such methods usually focus on students thinking and perception abilities (Dochy F. J. & McDowell, 1997). The logic of those methods lie behind the student oriented education systems. The main idea of the student-oriented education systems is the fact that the students are not passive minds to grab the knowledge from professionals but the architects of the key learning process, who start and control it. This process gives more freedom to students on learning speed and tools while limiting the traditional responsibilities of the educators (Barraket, 2005).

Assessment of accounting education needs to be conducted in three stages; input, transaction and output (Colarelli, 1991). While the inputs of accounting education are internal and external factors, the transaction process deals with the impact of the school on students. Finally, outputs of accounting education include the contributions of this process to the students (Torkzade & Moghadam, 2012).

The first stage of the performance assessment addresses the abilities of students that is used in the process. The second stage concentrates the service evaluation. In other words, this stage investigates the outcomes of the students, rather than their activities during the transaction process. The last stage, however, examines both the process and the outcomes together. As a result, it enables decision-makers to evaluate both the system as a whole and the students' success individually (Protheroe, 2001).

In this context, statistical process control (SPC) can be adopted to online accounting education assessment process as a valuable tool to determine the students' understanding of accounting knowledge and the progress of their learning experience to assess the performance of the e-learning system.

As details given in the following section, a SPC-based online accounting education assessment tool has been introduced in this study. After briefly presenting the SPC charts, a case study on the students of an online course, having accounting education at undergraduate level during the COVID-19 pandemic has been presented. The findings and the suggestions are given in the subsequent sections.

2. STATISTICAL PROCESS CONTROL

One of the prerequisites of Total Quality Management philosophy is ongoing quality control and improvements efforts. Statistical process control is one of the commonly accepted approaches to use in continuous quality control. SPC uses various control charts to determine problems in the process and alerts decision makers when out-of-control conditions happen. Hence, SPC is known as a significant supportive tool for executives to keep business processes under control (Evans & Lindsay, 1996).

Different control charts serve different needs. For instance, while the $\overline{X}$ control charts monitor a variable's data when samples are collected at regular intervals from a process, the p and the c charts monitor the proportion of nonconforming units in the sample (Nist/Sematech, 2012).

The p chart is used to determine if the fraction of defective items in a group of items is consistent over time. There are only two possible outcomes: either the item is defective, or it is not defective. The c chart is occasionally used to monitor the total number of events occurred in a given unit of time. It differs from the p chart in that it accounts for the possibility of more than one nonconformity per inspection unit, and that it requires a fixed sample size (Montgomery, 2005).

The control charts are used to detect whether a process is statistically stable. The process statistics are plotted as the center line along with the upper control limit (UCL) and lower control limit (LCL). The main principle of the control charts is to keep the data points between the control limits as any point beyond the limits suggests out-of-control conditions that require immediate action to find the source of the problem.

In the control charts, the quality of the individual points of a subset is determined unstable if any of the following occurs (Nist/Sematech, 2012):

- If one or more points falls outside of the upper or lower control limits.
- If two out of three successive data points fall in the area that is beyond two standard deviations from the process mean (center line).
- If four out of five successive data points fall in the area that is beyond one standard deviation from the process mean.
- If there is a run of six or more data points that are all either successively higher or successively lower in $\overline{X}$ control charts.
- If eight or more data points fall on either side of the process mean.
- If 15 points in a row fall within the area on either side of the center line that is one standard deviation from the process mean.

Although SPC is not a Decision Support System (DSS) that help decision makers to suggest the solutions for out-of-control conditions, it is an important tool to alert the executives to take necessary actions against the out-of-control conditions immediately. In other words, SPC only provides timely warnings about the unexpected problems in the process to figure out the reasons and to develop corrective decisions. Hence it is important for decision makers to understand the sources of the problems in the process to fix it (Tunca & Sutcu, 2006).

3. USE OF SPC TO ASSESS THE PERFORMANCE OF ONLINE STUDENTS

Even if the SPC charts have been widely used in manufacturing industry, there are several examples of its successful use in service industry (Guh et al. 1999). Nevertheless, there is no SPC use in education to best of the authors knowledge. Hence, in this paper it is aimed to exemplify the use of the SPC charts to examine the performance of online students.

In order to improve the quality of an online accounting course, the c control chart has been used to observe the weekly performance of the students during the term. In order to do that, every week, a quiz that consist of 10 questions about the teaching material has been provided to the students immediately after finishing the course to solve the questions in 15 minutes time. The number of wrong answers and the most common misunderstood subjects have been recorded every week. As a result, while collecting the data for the c control chart, it was also possible to determine which subjects online students mostly confuse to provide additional teaching sessions.

As seen in Table 1, the average number of unanswered or wrongly answered questions has been recorded as defected items to draw the c control chart in Figure 1, which is drawn by WinQSB software.

Table 1. Weekly Subjects and The Average Number of Unanswered or Wrongly Answered Questions

Week	Subject	Defected Items
1	General concepts	3
2	Principles of accounting	4
3	Balance sheet and income statement	3
4	Accounting plan	4
5	Accounting process and documents	2
6	Liquid assets	4
7	Marketable securities	3
8	Trade receivable	2
9	Inventories	4
10	Shot-term loans	3
11	Tangible fixed assets	2
12	Intangible fixed assets	2
13	Long term loans and equities	1

Notation of c control charts are given below:

C : Number of defective items

n : sample size

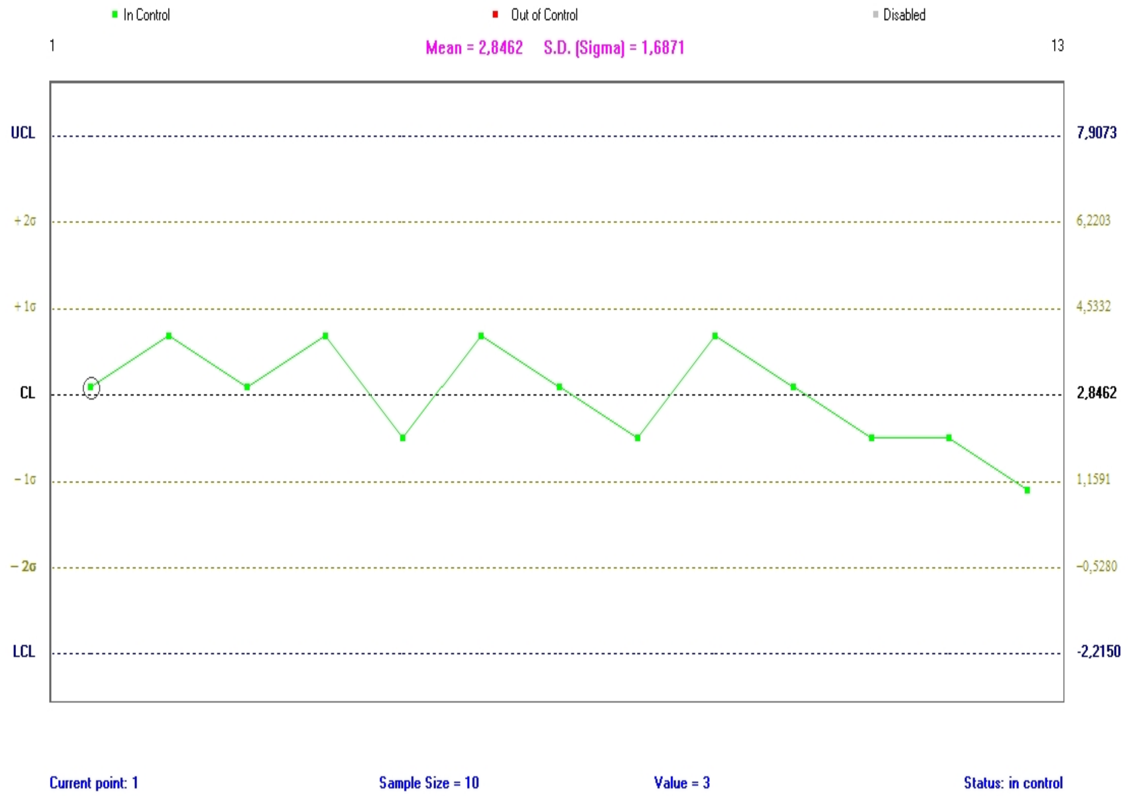
$\overline{C}$: Average number of defective items

Process mean = $\overline{C} = \dfrac{\sum C}{n}$

Upper control limit (UCL) = $\overline{C} + 3\sqrt{\overline{C}}$

Lower control limit (LCL) = $\overline{C} - 3\sqrt{\overline{C}}$

Figure 1. C Control Chart



As seen in Figure 1, the weekly observed data points fall ideally between the control limits. The distribution of the points suggests that there is no out-of-control condition exist in the learning process of the students.

Unlike the $\overline{X}$ control charts, the c charts aim to reduce the number of defective items in the process, where upward or downward trends of the data points to any control limit is acceptable. The downward trend of the data points to the lower control limit in the last five weeks suggest that the average ndesiumber of unanswered or wrongly answered questions tend to decrease, ie. students' learning abilities is incrementally improving.

4. CONCLUSION

Since exam is still the most important way in education system to assess students' performance even in online environments, it is important to determine the factors that influence the success of the students in exams. For instance, while sometimes poorly designed exams affect the students' success, sometimes the quality of the lectures or teaching materials could be the reasons of the failures. Hence, continuous efforts on improving the education and assessment system must be priority of the educators especially in online education.

In this study, Statistical Process Control is introduced as a tool for continuously observing the performance of online students. The online learning systems allow both educators and administratives to observe students' weekly performance to take immediate action as soon as their performance decreases.

The findings of this study suggest no significant decrease in students' performance. Hence, it was not necessary to take immediate action against the out-of-control conditions. The most important requirement of statistical process control is gathering indiscrete and standard observations. Under normal circumstances, at least 30 observations are expected for accurate results. In this study, only 13 observations have been used as the academic calendar reserve 13 weeks for lectures, and 3 weeks for mid-term and final exams. Nevertheless, it is important to repeat this process in the following terms for different courses to get sustainable results. Furthermore, in the further studies, different online student groups, having the same course in different programs can be investigated to observe the differences. of graduated students in addition to students' weekly performance.

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