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Monitoring General Education Course Performance Using Statistical Process Control Technique: A Multi-Program Analysis

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This study examines the use of Statistical Process Control (SPC), with a focus on the P-chart, to monitor performance in General Education (GE) core courses in higher education. GE courses help build students' foundational knowledge and skills, so a systematic and objective evaluation is needed. The study used a quantitative research design and analyzed secondary data from three academic programs: the Bachelor of Science in Marine Biology (BSMB), the Bachelor of Science in Information Technology (BSIT), and the Bachelor of Technology and Livelihood Education (BTLEd). Data covered three academic years, from 2021 to 2024. The P-chart was used to determine the proportion of nonconforming student performance and to assess process variation and stability across programs and time. Results revealed a general trend of improvement and increased process stability, particularly in the most recent academic year. However, multiple out-of-control points were observed during the pandemic period, which may be attributed to disruptions such as limited face-to-face instruction and unstable internet connectivity. The findings demonstrate that SPC techniques are effective in identifying performance variability and pinpointing courses that require targeted instructional interventions. This study underscores the value of SPC as a tool for continuous quality improvement in GE instruction at USTP–Panaon and proposes a replicable model for integrating statistical monitoring tools into educational evaluation and quality assurance practices in higher education institutions .

***Keywords*:** Statistical Process Control, P-chart, General Education Core Courses.

General Education (GE) core courses play a critical role in equipping students with the foundational knowledge, skills, and values necessary for academic success and professional readiness. In the Philippine higher education system, the Commission on Higher Education (CHED) underscores the importance of continuous quality improvement and outcomes-based evaluation through policy frameworks such as the *Policy-Standard to Enhance Quality Assurance (QA) in Philippine Higher Education through an Outcomes-Based and Typology-Based QA* (CHED 2012). This policy emphasizes that higher education institutions must regularly assess and enhance their academic programs, including General Education (GE), to ensure alignment with institutional outcomes, societal needs, and the demands of a rapidly evolving, knowledge-driven global environment. Complementing this, CHED Memorandum Order No. 20, Series of 2013, institutionalizes the GE curriculum as a holistic, competency-based framework designed to develop learners' intellectual, personal, and civic capacities. It further highlights the need for GE programs to remain dynamic, interdisciplinary, and responsive to contemporary challenges. As educational demands continue to evolve in response to global and

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local developments, higher education institutions must adopt more rigorous, data-driven, and responsive mechanisms to sustain the quality and effectiveness of GE instruction.

Despite their importance in promoting interdisciplinary learning, improving student engagement, and supporting long-term academic success, GE courses are often evaluated using traditional assessment methods that rely heavily on subjective judgment. While these approaches provide useful insights, they may lack the precision and objectivity needed for timely, evidence-based decision-making. Prior research underscores that systematic evaluation of GE programs is essential for aligning curricular outcomes with institutional goals, strengthening quality assurance processes, and enhancing student performance (Zhao & Zhou, 2021). Moreover, continuous assessment supports institutional accountability and compliance with accreditation standards.

To address these limitations, this study explores the application of Statistical Process Control (SPC) as an alternative, data-driven approach for evaluating GE course performance. SPC, originally developed by Walter A. Shewhart in 1924, has been widely used in manufacturing to monitor process behavior, control variability, and improve quality outcomes. Over time, its application has expanded across various sectors, demonstrating its adaptability in analyzing complex systems. Recent studies highlight its effectiveness in optimizing industrial processes, such as improving packaging quality (Pimentel et al., 2022), reducing production defects (Fuentes et al., 2023), enhancing project monitoring (Vigor et al., 2022), and minimizing defects in the production of UPVC Sanitary Pipes (Cabunita & Namoco,2024).

In educational and student services contexts, SPC which is often integrated within Statistical Quality Control (SQC), has been increasingly utilized to monitor academic performance, evaluate instructional effectiveness, and identify areas requiring intervention. Empirical studies have demonstrated its application in assessing academic program outcomes (Gessa et al., 2022), improving teaching quality (Bi, 2022), analyzing licensure examination performance (Capilitan et al., 2022).Recent research also highlights its effectiveness in enhancing service quality in higher education, such as in university cafeteria services (Moralia & Namoco Jr., 2024) and registrar operations (Chavez & Namoco Jr., 2024), demonstrating its versatility in improving both academic and institutional processes. Additionally, SPC techniques have been employed to examine grade distributions and academic trends across disciplines (Milnikova, 2011; Taiwo, 2019; Montgomery, 2009), highlighting their capacity to support data-driven decision-making in higher education.

The present study seeks to contribute to the growing body of literature advocating for SPC in higher education by applying the P-chart technique to analyze trends in student performance in GE core courses at the University of Science and Technology of Southern Philippines (USTP)-Panaon. Drawing on data from three academic programs, Bachelor of Science in Marine Biology (BSMB), Bachelor of Science in Information Technology (BSIT), and Bachelor of Technology and Livelihood Education (BTLEd) over three academic years (2021–2024), the study aims to assess variations in student performance and identify areas for improvement.

Through distinguishing between assignable and random causes of variation, this study aims to provide actionable insights into the effectiveness of GE instruction, enhance the quality of course delivery, and inform strategic program enhancements. Ultimately, the findings are expected to demonstrate the value of SPC as a quality assurance mechanism, not only for USTP-Panaon but also as a replicable model for other higher education institutions aiming to improve their general education curricula through data-driven evaluation methods.

Research Questions

RQ1.*What is the fraction of nonconforming student performance in GE core courses over three academic years in terms of program:*

(a) Bachelor of Science in Marine Biology (BSMB)

(b)Bachelor of Science in Information Technology (BSIT) and

(c) Bachelor in Technology Livelihood Education (BTLEd)?

RQ2. *How does GE course performance compare across BSMB, BSIT, and BTLEd programs in terms of variation, trends, and process stability?*

RQ3. *How does the fraction of nonconforming student performance in GE core courses change across academic years, and what patterns of stability are observed based on P-chart analysis?*

RQ4. *Which GE core courses and programs exhibit variability or out-of-control conditions requiring intervention?*

Method

Research Design

This study used a quantitative descriptive research design. It employed Statistical Process Control (SPC) techniques, specifically the P-chart, to evaluate performance rates of General Education (GE) core courses. The P-chart, or proportion chart, is a statistical tool that monitors the proportion of nonconforming units in a process over time (Reid & Sanders, 2019). In this study, the P-chart was used to analyze variations and stability in student performance across academic programs and time periods. This approach provided a data-driven method for educational evaluation. The analysis concluded that using the P-chart facilitated the identification of trends and variations in student performance, supporting continuous improvement in GE core courses.

Research Setting

The study was conducted at the University of Science and Technology of Southern Philippines (USTP)-Panaon Campus. The institution offers three undergraduate programs Bachelor of Science in Marine Biology (BSMB), Bachelor of Science in Information Technology (BSIT), and Bachelor of Technology and Livelihood Education (BTLEd). The analysis focused on selected General Education (GE) core courses offered across the identified programs during the academic years included in the study.

Population, Sample Size, and Sampling Technique

The study used secondary data comprising official student academic records obtained from the university registrar. The population included all officially enrolled students in BSMB, BSIT, and BTLEd programs who were enrolled in selected General Education (GE) core courses from Academic Year 2021–2024.

The study employed complete enumeration or census, which involves the inclusion of every unit or member of the population in the analysis(Australian Bureau of Statistics*)*. In this study, all available student-course enrolment records for the identified General Education (GE) core courses were included.Thus, no sampling procedure was applied in the study.

In addition, the unit of analysis was the course-level enrolment record rather than individual students, since a student may appear in multiple GE courses across academic terms. Only records from the identified GE core courses were included in the analysis, while courses outside the selected GE subjects and records with incomplete or unavailable academic information were excluded to ensure data consistency and accuracy.

Data Collection Technique and Classification

Secondary data were obtained from the university registrar and consisted of official student performance records. The analysis focused on selected General Education (GE) core courses, namely Understanding the Self (UTS), Readings in Philippine History (RPH), The Contemporary World (TCW), Mathematics in the Modern World (MMW), Purposive Communication (PurCom), Art Appreciation (ArtApp), Science, Technology, and Society (STS), and Ethics.These courses were selected based on the provisions of CHED Memorandum Order (CMO) No. 20, s. 2013, which outlines the prescribed GE curriculum for higher education institutions. This ensures that the study subjects are standardized and aligned with national

guidelines, thereby serving as the basis for inclusion in the analysis. Courses outside these identified GE subjects were excluded to maintain consistency.

Student performance was classified into two categories: conforming (passing) and nonconforming (non-passing) (Taiwo, 2019). Conforming students were those who successfully met course requirements within the prescribed period. Nonconforming students included those who received failing grades (5.0), incomplete (INC), officially dropped (ODP), or unofficially dropped (DP). These categories were grouped as nonconforming because all represent unsuccessful completion of course requirements during the academic term. In Statistical Quality Control (SQC), a nonconforming unit is any unit that does not meet the expected standard or specification (Montgomery, 2020). Since the study aimed to examine variation and process stability in academic performance using P-charts, all records indicating unsuccessful course completion were treated as indicators of nonconforming performance. However, the classification was used primarily for process monitoring and statistical analysis and does not imply that all nonconforming outcomes resulted from the same underlying cause.

Data Gathering

The researcher first obtained permission from the appropriate university offices to access official student performance records from the university registrar. The study used secondary data comprising official student performance records from core General Education (GE) courses. The GE courses included in the study were identified based on CHED Memorandum Order No. 20, s. 2013 to ensure that the subjects analyzed aligned with the prescribed GE curriculum. The collected records were organized by academic year and academic program: BSMB, BSIT, and BTLEd. Student performance was then classified into two categories: conforming (passing) and nonconforming (non-passing). Nonconforming records included students who received failing grades (5.0), incomplete (INC), officially dropped (ODP), or unofficially dropped (DP).

Data Analysis

The study employed Statistical Process Control (SPC), specifically the P-chart, to analyze variation, trends, and process stability in GE course performance across the three academic programs. The fraction nonconforming (p) was computed by dividing the number of nonconforming students by the total number of enrolled students per course. The center line (CL), upper control limit (UCL), and lower control limit (LCL) were then calculated to assess whether the observed variation fell within acceptable control limits. The resulting P-charts were used to identify trends, compare variability across programs and academic years, and determine whether the performance process was stable or affected by special causes of variation.

Construction of P-Chart

The P chart was selected as the most appropriate SPC tool for measuring the proportion of nonconforming students. The study utilizes MS Excel to construct P-charts. Below is an elaboration of its calculations:

1. Identify the nonconforming and total enrolment records. The number of nonconforming student-course records (d) and the total number of student-course enrolment records (n) were identified for each General Education (GE) core course, academic program, and academic year. The fraction nonconforming $(p)$was computed using the formula:

$$p = \frac{d}{n}$$

where p is the fraction nonconforming, d is the number of nonconforming student-course records, and n is the total number of student-course records for a specific course.

2. Compute the center line. It is also known as p-bar ($\bar{p}$), was computed by dividing the total number of nonconforming records by the total number of student-course records:

$$\bar{p} = \frac{\sum d}{\sum n}$$

where $\sum d$ represents the total number of nonconforming records and $\sum n$ represents the total number of student-course records analyzed.

3. Calculate the upper and lower control limits. The upper control limit (UCL) and lower control limit (LCL) were computed using the following formulas:

$$UCL = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

$$LCL = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

where $\bar{p}$ represents the center line, and n represents the enrolment size for each course.

4. If $LCL < 0$, it was set to zero to maintain interpretability.
5. Construct separate P-charts**.** Separate control limits and P-charts were computed for each academic program and academic year to account for differences in enrolment size and student-course records.
6. Chart Interpretation: Data points were plotted against the control limits to assess whether the process was in control (all points within bounds) or out of control (one or more points outside bounds).

It is presumed that the process is in control and that no further intervention is required as long as the points remain within its control limits. However, any point plotted outside the range of control is seen as evidence of an out-of-control process, necessitating more inquiry to identify and address the assignable cause(s) behind this behavior (Skinner, Runger, & Montgomery, 2006).

Ethical Consideration

This study adhered to established ethical standards in the use of student academic records. Prior to data collection, formal permission to access the records was secured from the appropriate university offices, including the Campus Director, Academic Head, and the Research, Extension, and Innovation Office. The study complied with the Data Privacy Act of 2012 (RA 10173) and institutional ethical guidelines. The research utilized anonymized secondary data obtained from the university registrar; thus, all personally identifiable information, such as student names and identification numbers, was removed prior to analysis to ensure confidentiality and privacy. The data were used solely for research purposes and were securely stored in password-protected files accessible only to the researcher. Since the study involved anonymized secondary data and no direct participant involvement, it was treated as a minimal-risk study in accordance with institutional ethical guidelines.

Results and Discussion

RQ 1*: What is the fraction of nonconforming student performance in GE core courses over three academic years in terms of program: (a) BSMB, (b) BSIT, and (c) BTLEd?*

Bachelor of Science in Marine Biology (BSMB)

Table 1 presents the fraction nonconforming (p) and the control limits (CL, UCL, LCL) for BSMB students' performance in General Education courses across three academic years.

A clear improvement is seen over time. In 2021–2022, several courses, particularly Art Appreciation, exceeded the upper control limit, indicating unstable performance and external disruptions. This pattern is consistent with studies showing that the sudden shift to remote learning during the pandemic negatively affected student engagement and outcomes (Daniel, 2020; Dhawan, 2020).

In 2022–2023, most values fall within the control limits, suggesting reduced variability and improved consistency. This reflects a period of adjustment in which both students and instructors became more familiar with new learning modalities (Hodges et al., 2020). By 2023–2024, all courses are within control limits and closely clustered around the center line, indicating a stable and predictable process. From a statistical perspective, this suggests that performance variation is now attributable to common causes rather than to disruptions (Montgomery, 2009).

Overall, the table shows a shift from unstable to stable performance, supporting the study's claim that student outcomes improved over time as teaching strategies and learning conditions became more effective.

Table 1

Fraction Nonconforming (p) and Control Limits for BSMB Students' Performance in General Education Core Courses

Academic Year	Course Code	Sample size (n)	Non-conforming (d)	Fraction Nonconforming (p)	Center Line ($\bar{p}$)	Upper Control Limit (UCL)	Lower Control Limit (LCL)
2021-2022	UTS	143	30	0.210	0.221	0.325	0.117
	RPH	145	35	0.241	0.221	0.324	0.118
	TCW	111	34	0.306	0.221	0.339	0.103
	MMW	87	11	0.126	0.221	0.354	0.087
	PurCom	89	4	0.045	0.221	0.353	0.089
	ArtApp	50	22	0.440	0.221	0.397	0.045
	STS	56	11	0.196	0.221	0.387	0.055
	Ethics	47	14	0.298	0.221	0.402	0.039
	Rizal	37	8	0.216	0.221	0.426	0.016
TOTAL		765	169	2.079			
2022-2023	UTS	228	44	0.1929	0.119	0.183	0.0546
	RPH	233	31	0.1330	0.119	0.182	0.0553
	TCW	211	14	0.0664	0.119	0.186	0.0520
	MMW	99	11	0.1111	0.119	0.216	0.0213
	PurCom	98	8	0.0816	0.119	0.217	0.0208
	ArtApp	109	13	0.1192	0.119	0.212	0.0259
	STS	36	2	0.0556	0.119	0.281	0.001
	Ethics	44	6	0.1364	0.119	0.265	0.001
	Rizal	44	2	0.0455	0.119	0.265	0.001
TOTAL		1102	131	0.9418			
2023-2024	UTS	312	24	0.0769	0.083	0.1293	0.0358
	RPH	325	25	0.0769	0.083	0.1284	0.0368
	MMW	171	17	0.0994	0.083	0.1457	0.0194
	PurCom	98	8	0.0816	0.083	0.1660	-0.0008
	STS	75	7	0.0933	0.083	0.1779	-0.0128
TOTAL		*981*	*81*	0.4282			

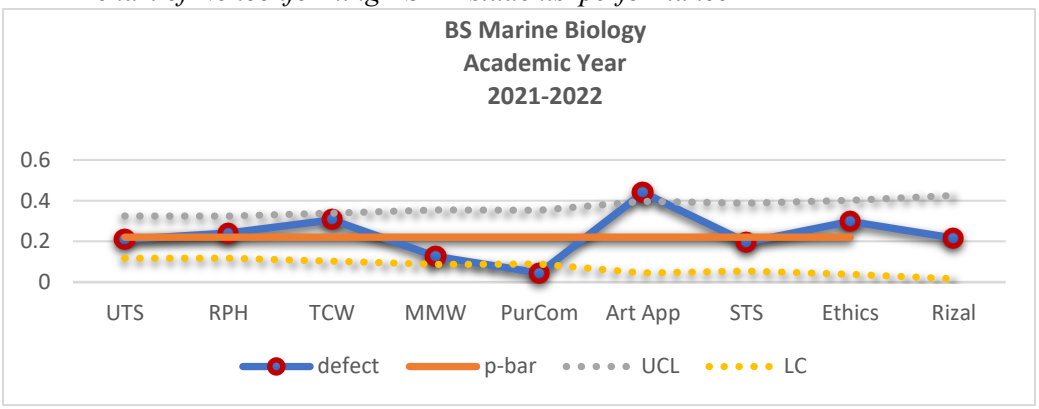
The P-chart presented in Figure 1 further illustrates the trend and stability of student performance across the three academic years. The chart shows a clear downward trend in defect rates, with earlier data points exhibiting higher variability and later points falling within the control limits. This pattern indicates a transition from an initially unstable process to a more stable and controlled system.

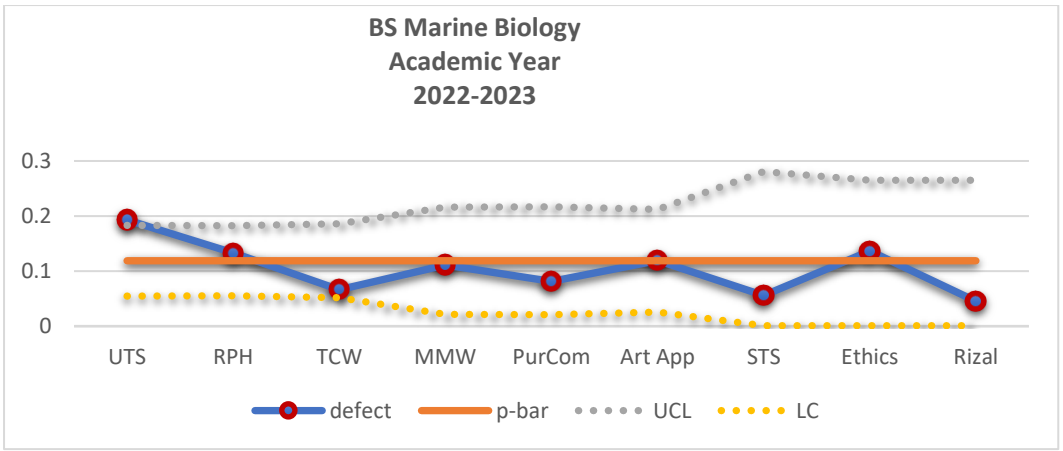
The observed reduction in variability and the clustering of data points within control limits in 2023–2024 suggest that the GE course performance in the BSMB program has achieved statistical stability. From an SPC perspective, this implies that assignable causes of variation may have been minimized, and the process has become more predictable.

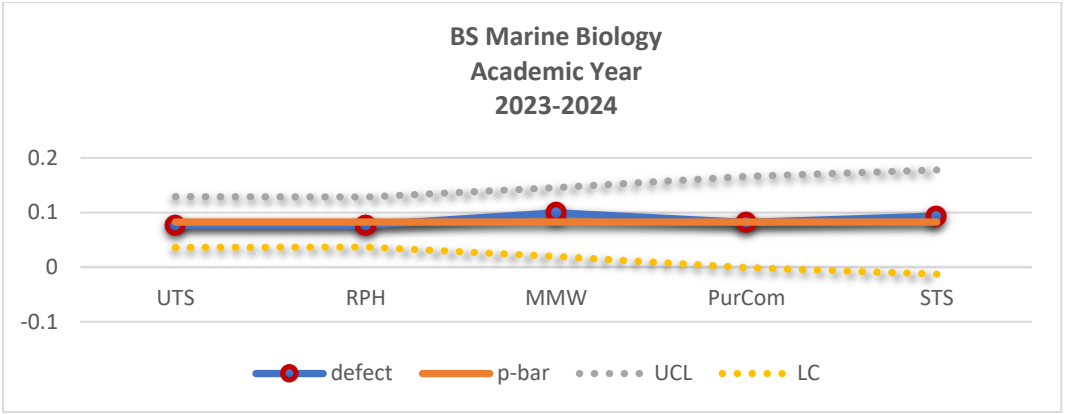
Overall, the findings demonstrate that the variations in student performance across the three academic years reflect a consistent improvement trend and the attainment of process stability. This improvement may be attributed to the implementation of effective instructional strategies and the gradual transition back to face-to-face learning, which enhanced student engagement and learning outcomes.

Figure 1

P-chart of Nonconforming BSMB students' performance







The disruption caused by the COVID-19 pandemic necessitated a rapid transition from traditional face-to-face instruction to online learning, which may have contributed to challenges such as limited interaction, reduced student engagement, and technological constraints. These conditions may have contributed to the greater variability in student performance observed in the early academic years (Dhawan, 2020; Hollister et al., 2022).

However, the P-chart analysis indicates that by Academic Year 2023–2024, GE course performance in the BSMB program achieved greater process stability. This was reflected in the reduced variability and clustering of data points within the control limits, suggesting that performance outcomes became more consistent and predictable over time. From a Statistical Process Control (SPC) perspective, this may indicate that assignable causes of variation were minimized and that the educational process became more stable.

The observed improvement in student performance may be associated with adjustments in instructional delivery and the gradual transition back to face-to-face learning. Flexible learning approaches, greater familiarity with online platforms, and increased classroom interaction may have contributed to more consistent learning outcomes. Previous studies also suggest that well-structured online and blended learning environments can support student learning when adequate instructional support and interaction are present (Hodges et al., 2020). Nevertheless, these factors were not directly measured in the study and are presented only as possible explanations supported by related literature.

Bachelor's in Information Technology (BSIT)

Table 2 illustrates the performance of BSIT students in General Education Core Courses over three academic years, highlighting a significant improvement. In 2021-2022, with 484 students, the fraction nonconforming was high at 1.9909, with Art Appreciation having the highest rate (0.4063). By 2022-2023, with 524 students, the fraction nonconforming dropped to 0.6866, with notable reductions in courses like Purposive Communication (0.0339) and Art Appreciation (0.0308). In 2023-2024, further improvements were evident, with 396 students and a fraction nonconforming of 0.3032, indicating that effective interventions and strategies had enhanced student performance over the years.

Table 2

Fraction Nonconforming of BSIT students' performance in General Education Core Courses

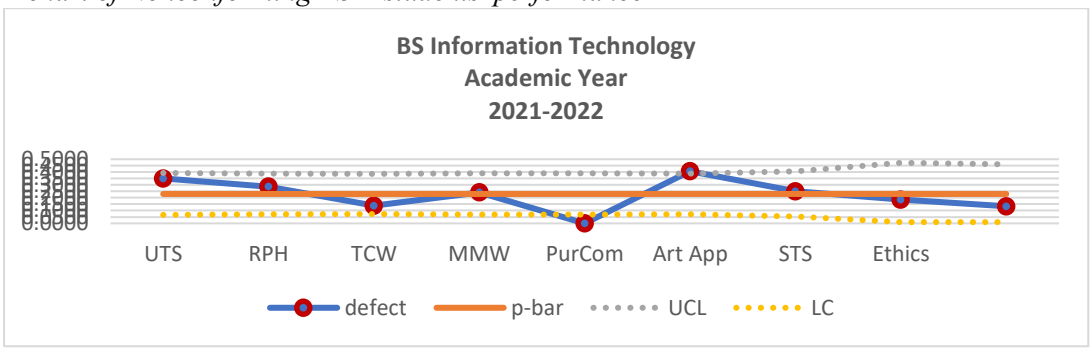
Academic Year	Course Code	Sample size (n)	Non-conforming (d)	Fraction Nonconforming (p)	Center Line ($\bar{p}$)	Upper Control Limit (UCL)	Lower Control Limit (LCL)
2021-2022	UTS	60	21	0.3500	0.2293	0.3922	0.0665
	RPH	63	18	0.2857	0.2293	0.3882	0.0704
	TCW	65	9	0.1385	0.2293	0.3858	0.0729
	MMW	62	15	0.2419	0.2293	0.3895	0.0692
	PurCom	61	0	0.0000	0.2293	0.3908	0.0679
	ArtApp	64	26	0.4063	0.2293	0.3869	0.0717
	STS	52	13	0.2500	0.2293	0.4042	0.0544
	Ethics	27	5	0.1852	0.2293	0.4721	0.01
	Rizal	30	4	0.1333	0.2293	0.4596	0.01
TOTAL		484	111	1.9909			
2022-2023	UTS	66	7	0.1061	0.0821	0.1834	0
	RPH	60	4	0.0667	0.0821	0.1884	0
	TCW	68	17	0.2500	0.0821	0.1819	0
	MMW	64	6	0.0938	0.0821	0.1850	0
	PurCom	59	2	0.0339	0.0821	0.1893	0
	ArtApp	65	2	0.0308	0.0821	0.1842	0
	STS	57	2	0.0351	0.0821	0.1911	0
	Ethics	43	2	0.0465	0.0821	0.2076	0
	Rizal	42	1	0.0238	0.0821	0.2091	0
TOTAL		524	43	0.6866			
2023-2024	UTS	100	7	0.0700	0.0758	0.1551	0
	RPH	102	8	0.0784	0.0758	0.1544	0
	PurCom	96	8	0.0833	0.0758	0.1568	0
	STS	98	7	0.0714	0.0758	0.1559	0
TOTAL		396	30	0.3032			

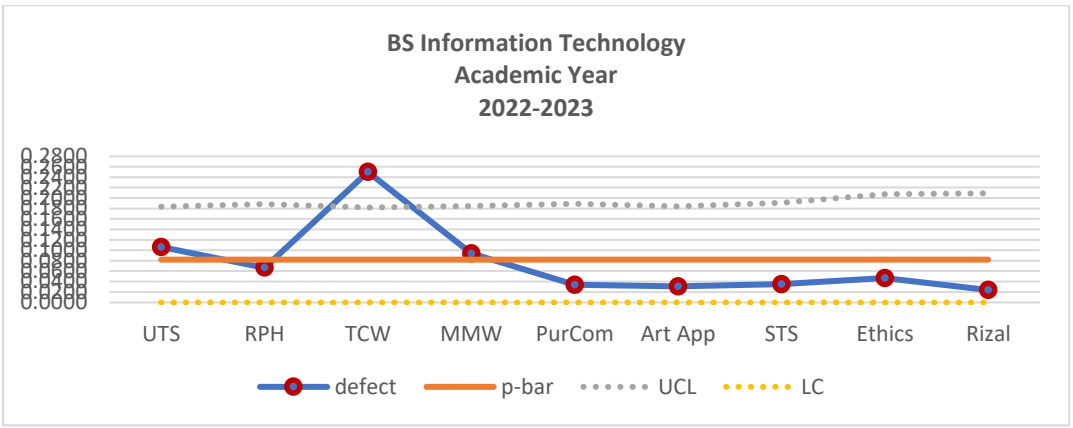
The P-chart in Figure 2 shows a steady decline in the proportion of nonconforming student performance and reduced variability across the academic years. The greater variability observed in 2021–2022 may be associated with challenges during the transition to online learning. By 2023–2024, most data points were within the control limits, indicating improved process stability and more consistent performance outcomes.

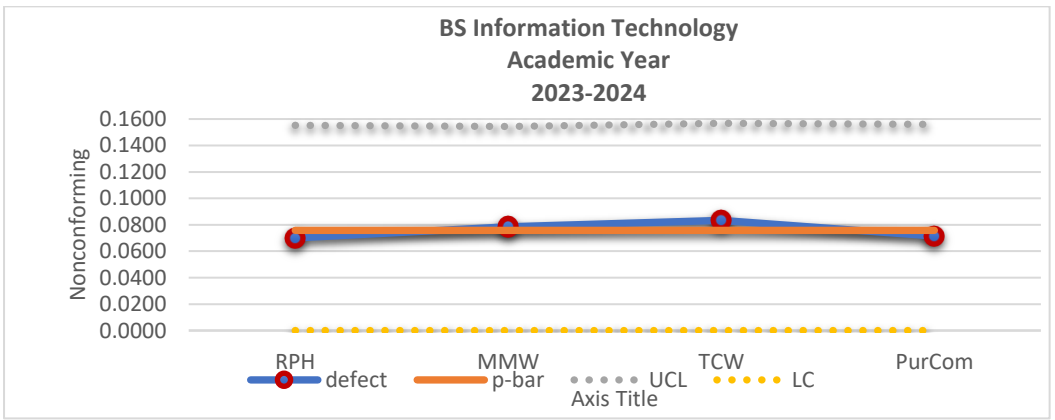
The observed improvement and stabilization in student performance may be linked to instructional adjustments and the gradual return to face-to-face learning. Previous studies noted that online learning environments may affect student engagement due to reduced interaction (Grebennikova et al., 2022), while pandemic-related disruptions may have negatively affected student motivation and academic performance (Tan, 2021). The findings highlight the possible importance of supportive learning environments and appropriate instructional strategies in promoting more consistent academic outcomes.

Figure 2

P-chart of Nonconforming BSIT students' performance







Bachelor in Technology and Livelihood Education (BTLEd)

Table 3 presents the fraction of nonconforming student performance in General Education (GE) core courses for the BTLEd program across three academic years. In 2021–2022, 157 of 985 students were nonconforming, yielding a fraction of nonconforming students of 1.4303, with high nonconformance in Art Appreciation (0.3000) and Ethics (0.2358). In 2022–2023, performance improved, with the fraction nonconforming decreasing to 1.0462 among 1069 students. By 2023–2024, the fraction nonconforming had fallen to 0.3684 across 924 students, indicating continued improvement in student performance.

The P-chart in Figure 3 shows fluctuations in the proportion of nonconforming student performance across the three academic years, with earlier periods exhibiting greater variability and several out-of-control conditions, particularly in Purposive Communication and Art Appreciation. These patterns suggest

inconsistent performance outcomes during the earlier academic period. Studies have noted that communication difficulties and limited access to stable internet connectivity may affect learner participation and the effectiveness of online learning environments (Ishtiaq et al., 2024). By 2023–2024, most data points fell within the control limits, indicating improved process stability and more consistent student performance across the identified GE courses

Table 3

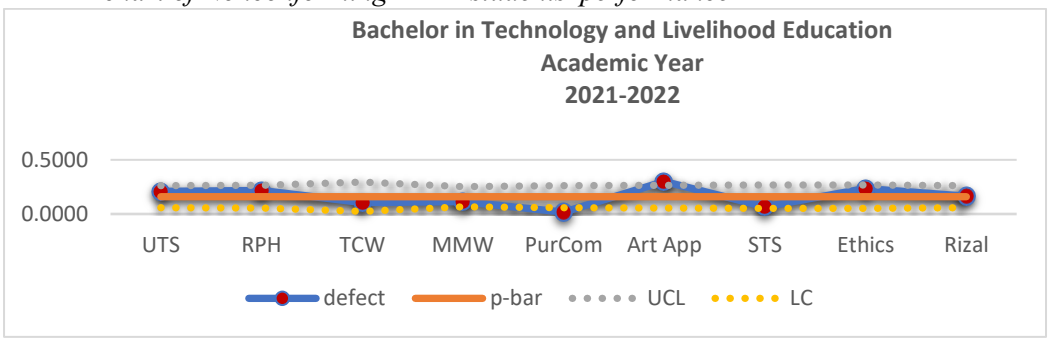
Fraction Nonconforming of BTLE students' performance in General Education Core Courses

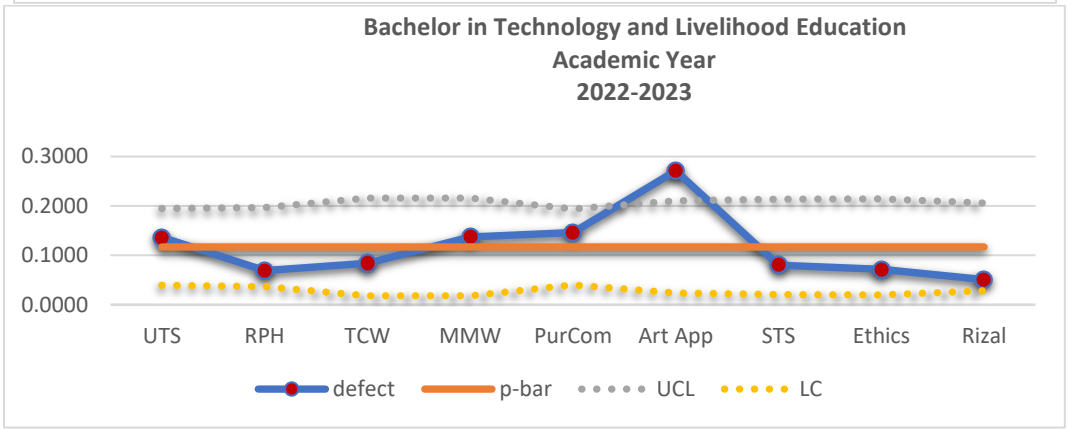
Academic Year	Course Code	Sample size (n)	Non-conforming (d)	Fraction Nonconforming (p)	Center Line ($\bar{p}$)	Upper Control Limit (UCL)	Lower Control Limit (LCL)
2021-2022	UTS	115	24	0.2087	0.1594	0.2618	0.0570
	RPH	111	24	0.2162	0.1594	0.2636	0.0552
	TCW	66	7	0.1061	0.1594	0.2946	0.0242
	MMW	139	16	0.1151	0.1594	0.2525	0.0662
	PurCom	117	2	0.0171	0.1594	0.2610	0.0578
	ArtApp	110	33	0.3000	0.1594	0.2641	0.0547
	STS	106	7	0.0660	0.1594	0.2661	0.0527
Table 3 (continued)							
	Ethics	106	25	0.2358	0.1594	0.2661	0.0527
	Rizal	115	19	0.1652	0.1594	0.2618	0.0570
TOTAL		985	157	1.4303			
2022-2023	UTS	154	21	0.1364	0.1169	0.1946	0.0393
	RPH	145	10	0.0690	0.1169	0.1969	0.0369
	TCW	95	8	0.0842	0.1169	0.2158	0.0180
	MMW	95	13	0.1368	0.1169	0.2158	0.0180
	PurCom	157	23	0.1465	0.1169	0.1939	0.0399
	ArtApp	107	29	0.2710	0.1169	0.2101	0.0237
	STS	100	8	0.0800	0.1169	0.2133	0.0205
	Ethics	98	7	0.0714	0.1169	0.2143	0.0196
	Rizal	118	6	0.0508	0.1169	0.2057	0.0282
TOTAL		1069	125	1.0462			
2023-2024	UTS	145	10	0.0690	0.0552	0.112088	0
	RPH	147	9	0.0612	0.0552	0.111699	0
	TCW	126	3	0.0238	0.0552	0.116227	0
	MMW	127	5	0.0394	0.0552	0.115986	0
	PurCom	154	17	0.1104	0.0552	0.1104	0
	ArtApp	143	4	0.0280	0.0552	0.112484	0
	STS	82	3	0.0366	0.0552	0.130849	0
TOTAL		396	30	0.3032			

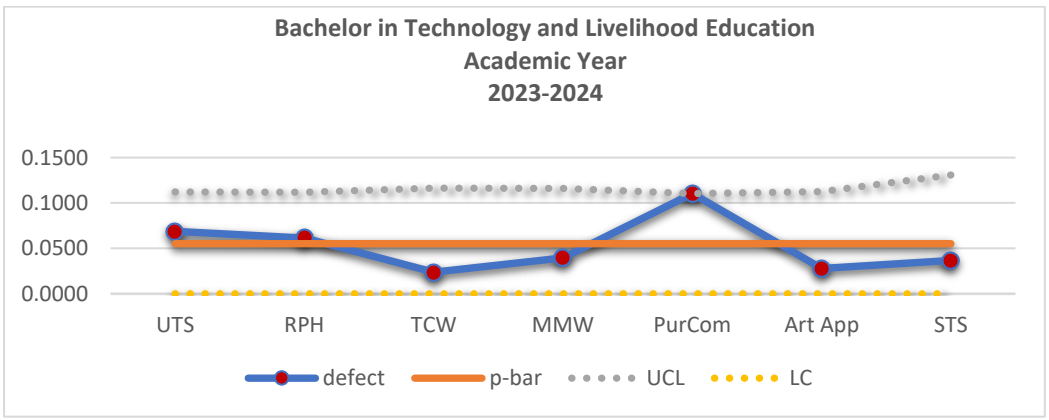
The observed improvement in Purposive Communication may reflect the gradual stabilization of learning conditions across the academic years. Previous studies noted that learning disruptions during the pandemic affected student participation and consistency in academic performance, particularly in courses requiring active communication and participation (Pokhrel & Chhetri, 2021; Ishtiaq et al., 2024). Overall, the findings indicate a transition from greater variability to improved process stability within the BTLEd program.

Figure 3

P-chart of Nonconforming BTLE students' performance







However, there has been a noticeable improvement in the PurCom course over the years. This improvement is likely due to the return of face-to-face classes, which students prefer and which provide a more conducive environment for learning and assessments. The face-to-face format has mitigated the issues related to internet connectivity, allowing students to engage more effectively in oral presentations and other interactive activities.

The challenges and impacts of online learning during the pandemic have been widely documented. According to Pokhrel and Chhetri (2021), the sudden shift to online learning posed significant challenges for students, especially those in remote areas with limited access to technology and stable internet connections. This aligns with the difficulties faced by BTLE students in Misamis Occidental. Furthermore, the effectiveness of face-to-face learning, particularly for activities requiring real-time interaction, such as oral presentations, has been highlighted in educational research. Face-to-face interactions provide immediate feedback and foster a more engaging learning environment (Bernard, et al., 2004).

RQ2*: How does GE course performance compare across BSMB, BSIT, and BTLEd programs in terms of variation, trends, and process stability?*

Figure 4 shows that GE course performance across the BSMB, BSIT, and BTLEd programs followed a similar pattern in variation, trends, and process stability. In 2021–2022, all programs exhibited high variability, with several data points near or beyond the control limits, indicating unstable performance.

Moreover, *Art Appreciation* was consistently non-conforming across all programs, likely due to the shift to remote learning during the COVID-19 pandemic. The outbreak significantly affected the education system and required the rapid adoption of distance learning approaches, which reduced teacher-student interaction and limited personal and emotional engagement (Grebennikova et al., 2022). This may be explained by the nature of the subject, which depends on demonstration, guided practice, and interaction.

In addition, the absence of face-to-face instruction likely limited student engagement and access to immediate feedback. Since art-related tasks require clear step-by-step guidance and modeling, the online environment made learning more challenging (Pressley et al., 1992). In addition, reduced interaction in virtual settings may have further affected student performance (Dhawan, 2020).

To support learning in online settings, instructional strategies such as recorded demonstrations, step-by-step guides, and accessible materials are important. Providing visual or annotated feedback, along with opportunities for reflection and critique, can also help improve student understanding and performance (Dyment & O'Connell, 2011).

Overall, GE course performance across the three programs shows a clear trend from high variability to process stability. While all programs followed a similar pattern, minor differences in the rate of improvement were observed, with some programs stabilizing earlier than others. These findings highlight the importance of guided, interactive, and feedback-driven instructional strategies, particularly for skill-based subjects such as Art Appreciation, in achieving consistent learning outcomes across diverse instructional settings.

RQ3*: How does the fraction of nonconforming student performance in GE core courses change across academic years, and what patterns of stability are observed based on P-chart analysis?*

Table 4 presents the fraction of nonconforming student performance across all programs in General Education (GE) core courses over three academic years. The results show a clear and consistent improvement in student performance over time. In 2021–2022, the overall fraction nonconforming was highest at 1.7734, with Art Appreciation (0.3616), Ethics (0.2444), and Readings in Philippine History (0.2414) exhibiting the greatest nonconformance. In contrast, Purposive Communication recorded the lowest fraction nonconforming (0.0225).

In 2022–2023, the fraction nonconforming decreased significantly to 0.9331, indicating improved performance across all courses. Notable reductions were observed in Science, Technology, and Society (0.0622) and Rizal (0.0441), while Art Appreciation improved to 0.1566. By 2023–2024, the fraction nonconforming further declined to 0.4805, reflecting substantial progress and increased consistency in performance. Courses such as The Contemporary World (0.0482) and Art Appreciation (0.0280) showed marked improvement, while Purposive Communication maintained relatively low defect rates (0.0930).

Figure 4

P-chart of Nonconforming students from the three programs

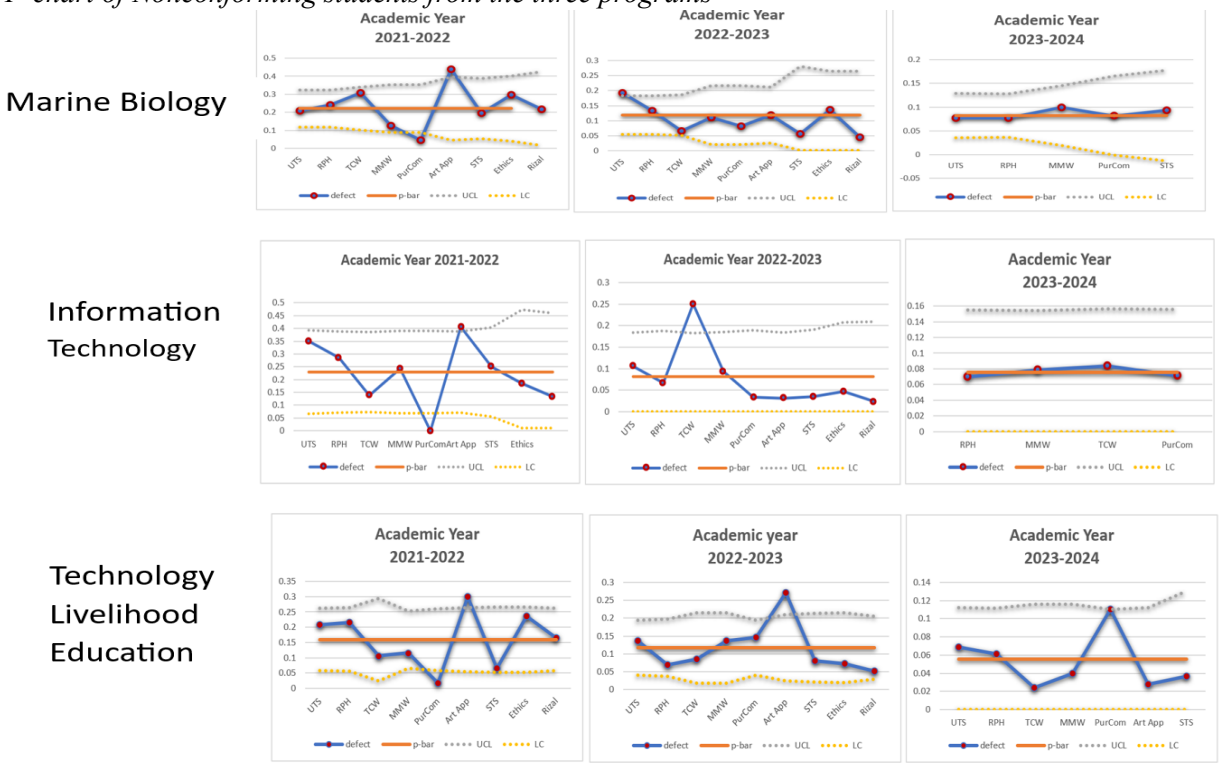


Table 4

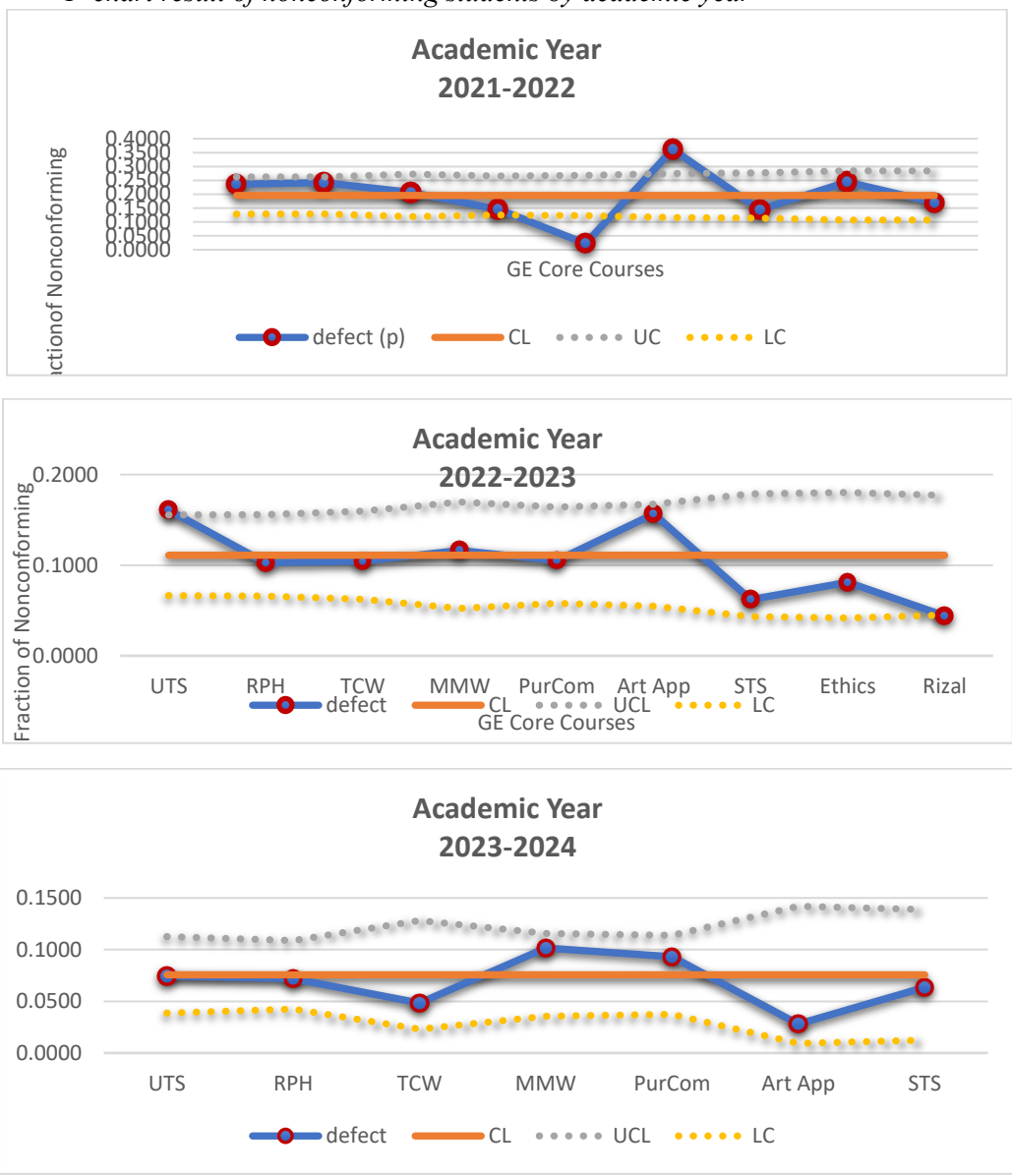
Fraction nonconformance of students for 3 academic years

Academic Year	Course Code	Sample size (n)	Non-conforming (d)	Fraction Nonconforming (p)	Center Line ($\bar{p}$)	Upper Control Limit (UCL)	Lower Control Limit (LCL)
2021-2022	UTS	318	75	0.2358	0.1956	0.2623	0.1289
	RPH	319	77	0.2414	0.1956	0.2622	0.1290
	TCW	242	50	0.2066	0.1956	0.2721	0.1191
	MMW	288	42	0.1458	0.1956	0.2657	0.1255
	PurCom	267	6	0.0225	0.1956	0.2684	0.1228
	ArtApp	224	81	0.3616	0.1956	0.2751	0.1161
	STS	214	31	0.1449	0.1956	0.2769	0.1143
	Ethics	180	44	0.2444	0.1956	0.2843	0.1069
	Rizal	182	31	0.1703	0.1956	0.2838	0.1074
TOTAL		2234	437	1.7734			
2022-2023	UTS	448	72	0.1607	0.1110	0.1555	0.0664
	RPH	438	45	0.1027	0.1110	0.1560	0.0660
	TCW	374	39	0.1043	0.1110	0.1597	0.0622
	MMW	258	30	0.1163	0.1110	0.1696	0.0523
	PurCom	314	33	0.1051	0.1110	0.1641	0.0578
	ArtApp	281	44	0.1566	0.1110	0.1672	0.0547
	STS	193	12	0.0622	0.1110	0.1787	0.0431
	Ethics	185	15	0.0811	0.1110	0.1802	0.0417
	Rizal	204	9	0.0441	0.1110	0.1769	0.0450
TOTAL		2695	299	0.9331			
2023-2024	UTS	457	34	0.0744	0.0756	0.1127	0.0385
	RPH	572	41	0.0717	0.0756	0.1088	0.0424
	TCW	228	11	0.0482	0.0756	0.1281	0.0231
	MMW	394	40	0.1015	0.0756	0.1156	0.0356
	PurCom	430	40	0.0930	0.0756	0.1138	0.0374
	ArtApp	143	4	0.0280	0.0756	0.1419	0.0093
	STS	157	10	0.0637	0.0756	0.1389	0.0123
TOTAL		2381	180	0.4805			

The P-chart in Figure 5 shows a gradual decline in defect rates and reduced variability across the three academic years. The wider spread of data points in 2021–2022 suggests greater instability during the implementation of online learning. By 2022–2023, variability decreased as students and instructors adapted to flexible learning modalities. In 2023–2024, most data points fell within the control limits, indicating improved process stability and more consistent student performance. These improvements may be associated with adjustments in instructional delivery and a gradual transition to more stable learning environments.

Figure 5

P-chart result of nonconforming students by academic year



During the 2021–2022 academic year, the transition to online learning during the COVID-19 pandemic may have contributed to challenges in student participation and engagement. Limited interaction, unstable internet connectivity, and difficulties in using technology were identified as common barriers in online learning environments (Hollister et al., 2022; Ishtiaq et al., 2024). These conditions may help explain the greater variability observed in student performance during this period. By 2022–2023, the reduction in variability may suggest that students and instructors gradually adapted to flexible learning modalities,

including asynchronous and synchronous approaches, which may have supported improved engagement and learning management (Raes et al., 2019).

Furthermore, in the 2023-2024 academic year, the stabilization of defect rates coincided with the return to face-to-face classes, which may have provided more consistent opportunities for interaction and feedback. The return to in-person learning provided students with more direct interaction with teachers and peers, enhancing their learning experience and motivation. This stability indicates that traditional classroom settings may be more effective in maintaining consistent academic performance compared to online or hybrid models (Gillett-Swan, 2017).

RQ4: *Which GE core courses and programs exhibit variability or out-of-control conditions requiring intervention?*

The findings indicate that several General Education (GE) core courses demonstrated notable variability and out-of-control conditions, particularly during the 2021–2022 academic year. Across the three programs, Art Appreciation and Purposive Communication consistently recorded higher proportions of nonconforming outputs and greater fluctuations in the P-chart. These patterns were most evident in the BTLEd program, suggesting unstable performance and the possible presence of assignable causes requiring intervention.

Variability was also observed in the BSMB and BSIT programs during the earlier academic year, particularly in courses involving communication and performance-based activities. Previous studies noted that the transition to online learning created difficulties in engagement and participation, especially in low-resource settings (Pokhrel & Chhetri, 2021). By the 2023–2024 academic year, greater stability was observed across most courses and programs, with data points generally falling within the control limits. This trend suggests improved consistency in academic performance over time.

These findings support the principle of Statistical Process Control (SPC) that out-of-control conditions may indicate the presence of assignable causes requiring corrective action (Montgomery, 2009). In educational settings, variability in performance may be associated with instructional delivery and learning conditions (Bi, 2022). Overall, the results suggest that Art Appreciation and Purposive Communication, particularly within the BTLEd program, may benefit from strengthened instructional support and continuous monitoring to promote more stable and consistent academic performance.

Conclusion

This study established the usefulness of Statistical Process Control (SPC), particularly the P-chart, as a data-driven approach for monitoring student performance in General Education (GE) core courses at the University of Science and Technology of Southern Philippines. By analyzing student performance in the BSMB, BSIT, and BTLEd programs over three academic years, the study identified variations, trends, and levels of process stability in GE course performance. The findings showed a gradual reduction in the proportion of nonconforming students and an improvement in process stability by the 2023–2024 academic year. Most courses demonstrated more consistent performance over time, although Art Appreciation and Purposive Communication continued to exhibit higher variability and out-of-control conditions, particularly in the BTLEd program. These findings suggest the presence of assignable causes that may require focused instructional support and continuous monitoring. Overall, the study highlights the value of SPC as a practical tool for evidence-based decision-making and continuous quality improvement in higher education. The use of P-charts allowed the institution to identify courses with unstable performance and monitor improvements across academic years, providing useful information for instructional planning and academic quality assurance.

Recommendations

Based on the findings of the study, the following recommendations are proposed:

1. Faculty handling Art Appreciation and Purposive Communication may provide more guided activities, step-by-step instructions, and regular feedback to help improve student performance.

2. Departments may conduct regular monitoring of GE course performance using P-charts to easily identify courses with high variability or increasing nonconforming rates.

3. Instructors may strengthen student support through consultation hours, remediation activities, and additional learning materials, especially for students at risk of failing or dropping courses.

4. The university may improve access to learning resources and internet support, particularly for students experiencing difficulties in online or flexible learning environments.

5. Training and workshops may be provided to faculty members on interactive teaching strategies and the use of data-driven approaches such as SPC in monitoring student performance.

6. Future researchers may examine factors such as student engagement, teaching strategies, internet connectivity, and learning preferences to better explain variations in academic performance.

Limitations

This study was limited to analyzing official student academic records for General Education (GE) core courses in the BSMB, BSIT, and BTLEd programs at a single institution. As a result, the findings may not be fully generalizable to other academic programs, universities, or educational contexts. Second, the research relied solely on secondary data and focused on the variation, trends, and process stability of student performance using Statistical Process Control (SPC). Key variables such as instructional strategies, student engagement, internet connectivity, socioeconomic status, and learning preferences were not directly measured. Any discussion of these factors was limited to interpretations supported by relevant literature. Third, the study grouped failing grades, incomplete marks, officially dropped, and unofficially dropped records as nonconforming outcomes for process monitoring. While these categories may have different underlying causes, they were combined to satisfy SPC analysis requirements and to monitor overall patterns of unsuccessful course completion. Despite these limitations, the study offers valuable baseline data on performance variation and process stability in GE core courses across academic years.

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