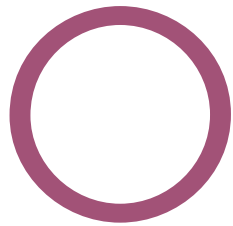


USING PROCESS VARIATION ANALYSIS TO MONITOR TEACHERS' PERFORMANCE

This article will explore the possibility of using process variation analysis or statistical process control . . . to monitor teacher performance and employing the findings to craft administrative responses that meet the needs of the teachers and students in each school.



ver the years, the purpose and methodology for evaluating teacher performance has changed significantly.¹ Traditionally, it was used to meet demands for public accountability. In recent years, the focus of these evaluations has shifted to helping teachers improve and develop professionally. Thus, the method of evaluating performance has evolved as well—from reliance on a supervisor's assessment to the use of multiple approaches, including student ratings, peer reviews, self-evaluations, document reviews, and other evidences of achievement.

Teacher evaluation is usually done to assess performance and productivity. In a conventional evaluation process, the supervisor (acting alone or in conjunction with his or her subordinate) sets objectives for a certain period of time, typically the upcoming school year. These objectives may focus on developing knowledge, skills, and results (such as output and productivity), or changing behavior. Evaluation often in-

volves the use of a performance-rating questionnaire, followed by a supervisor's review of accomplishments, strengths/weaknesses, and other characteristics related to the job being appraised. This process may be followed by announcements of raises, bonuses, or promotions.

As new purposes and audiences are added, the methods of evaluating teacher performance will probably also evolve. But will these changes help achieve the central purpose of the evaluation, which is to help teachers continually improve and develop, and enhance student learning? This article will explore the possibility of using process variation analysis or statistical process control (which will be explained in the next section) to monitor teacher performance and employing the findings to craft administrative responses that meet the needs of the teachers and students in each school.

Understanding Process Variation

All educational work occurs within a system of interconnected processes, which contain many sources of variation. By *variation*, we mean the extent to which or the range within which a thing or a process varies. For example, the instructors working at a school have different upbringings,

BY BEN A. MAGUAD





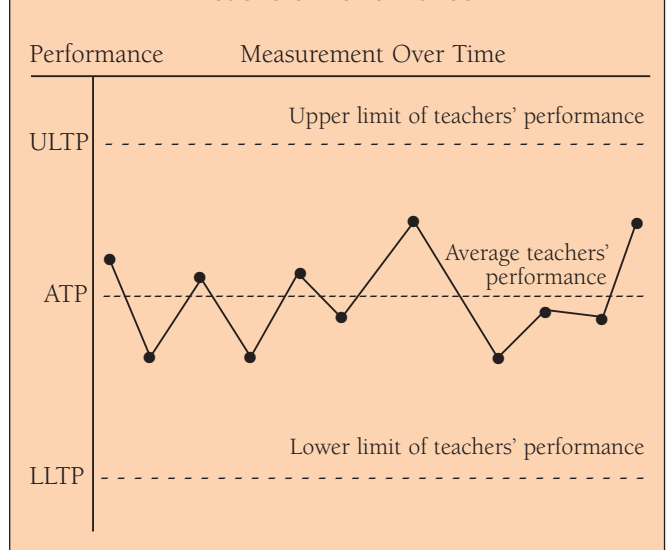
educational backgrounds, and working experiences, which makes each one unique in terms of personality and values. They work with different students, each of whom has a unique personality. They interact with various individuals (other instructors, administrators, and staff) on campus. They perform different kinds of tasks. They often utilize a variety of resources (e.g., textbooks, reference books, notes, writing instruments). Their work involves the use of different kinds of equipment, with varying features, capability, and performance. They work under different supervisors, who may have a variety of management styles. They are also affected by many environmental conditions (e.g., family relationships, noise level, the collegiality of the work environment, morale level, weather patterns, etc.) that exist at home, in their classrooms and labs, and within the institution as a whole. The complex interactions of these variations are not easily understood.

Variation due to these sources occurs randomly. However, their combined effect is presumed to be stable and predictable, and can be measured using statistical methods

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such as the control chart. According to statisticians, the factors that are present as a natural part of the process are referred to as *chance* or *common causes of variation*. Thus, a process that is being affected by this type of variation is said to be a stable process² and is referred to as being *in control*. Common-cause variation comes as a result of the design of the system. It is inherent in a process and generally ac-

Figure 1: Structure of a Control Chart for Evaluating Teachers' Performance



counts for about 80 to 95 percent of the observed variation in the outcome of that process.³

Although common-cause variation is inherent in any process, it is still possible to reduce it (which is, of course, the goal of long-term improvement) by redesigning the service, employing better technology, or providing extra training for those who participate in the process. Thus, the only way to reduce common-cause variation is to change the technology of the educational process—machines, people, materials, methods or measurement process—which is under the control of leadership (administrators, deans, department heads). However, if there is presently no way to upgrade the service, more advanced technology is not available or is beyond the means of the institution, and further training is unlikely to benefit the participants, the process should be left alone if only common-cause variation is present. Tampering with a stable system can increase the variation in the system and thus will only make it worse.

Special-Cause Variation

The other type of variation that may exist in an educational process results from *special causes*. Special causes can be attributed to external sources that are not inherent in a process. They produce unnatural variation that disrupts the random pattern of common causes. Thus, they tend to be readily detectable using statistical methods, and with foresight and commitment, can be prevented or corrected. When special-cause variations are present, the process is said to be *unstable* or *out of control*. Some examples of special-cause variations in education that could affect the performance of teachers are the hiring of unqualified, incompetent, or untrained administrators, faculty, or staff; the admission of students who are unprepared to do college work; malfunctioning equipment; inadequately equipped laboratories and libraries; dysfunctional interpersonal relationships; management by fear; a teacher's serious illness or accident; excessively warm or cold classroom temperatures; a food poisoning episode in the cafeteria; campus crime or civil unrest; extreme climatic changes; flooding, fire, or natural disaster; and many others. In general, these special-cause variations have an unpredictable effect on the outcome of teaching and learning and can seriously af-

fect the educational system as a whole. Therefore, whenever possible, they must be identified and prevented, remedied, or resolved in a timely manner.

A Control Chart for Education

A control chart, as applied to education, is defined as a run chart to which two horizontal lines, called control limits, have been added (see Figure 1 on page 28). The two lines are the upper and lower limits of teachers' performance (ULTP and LLTP). Control limits are chosen statistically to provide a high probability (generally greater than 0.99 or 99 percent) so that points (i.e., teachers' evaluation ratings) will fall between these limits if the process is in control. The limits also make it easier to interpret patterns in a run chart and to evaluate its state of control. (A detailed description of control charts and control limits is outside the scope of this paper. The interested reader is advised to consult a text on statistics or quality management for a more detailed discussion.) Control charts should not be used for ranking, as their usefulness lies in the area of performance monitoring. Their results can help administrators respond appropriately to the needs of the different groups of people represented in the control charts.

If sample values (e.g., a teacher's rating) fall outside the control limits (above ULTP or below LLTP), then special causes (defined earlier in the article) may be affecting the process. Thus, the process is not stable. It should be evaluated, and appropriate corrective action taken. If a teacher's rating is outside of the control limits, then something un-



usual is happening and is worth investigating. For example, ratings that fall above the capability of the system (above the ULTP line) represent exemplary performance by teachers. Conversely, ratings that fall below the capability of the system (below the LLTP line) represent inadequate or questionable performance.

Thus, performance ratings that use a numerical system based either on a single measure or on a weighted index of performance will tend to divide the teachers into three groups:

Group 1 - teachers who are outside the control limits on the plus side (outside the system; above ULTP);

Group 2 - teachers who are outside the control limits on the negative side (outside the system; below LLTP), and

Group 3 - teachers who are between the control limits (within the system; between ULTP and LLTP).

This grouping is not intended to rank teachers, but rather to provide administrators with a way to monitor teachers' performance over a period of time. A teacher whose rating falls in Group 1 may deserve special recognition. His or her expertise should be tapped and use of best practices analyzed for possible department-wide or institution-wide application. Those in Group 2 may need help from their colleagues, administrators, and others to improve their performance. But according to quality experts and statistical process control statisticians, those in Group 3 (people between the control limits), which comprise the majority of the teachers, must not be ranked. The primary reason is that both positive and negative differences among teachers' ratings within the control limits (between ULTP and LLTP) are the product of the system itself, not the teachers. There is no basis for making distinctions between teachers whose performance puts them in Group 3.

Institute Leadership

Most quality experts agree that quality is determined in the executive suite. The output of the organization cannot be better than the quality determined at the top. Deming⁴ states that in his own experience, most problems and most possibilities for improvement (about 94 percent) are attributable to the system. Only about six percent are attributable to special causes.

A good administrator will strive to discover which of his or her teachers performs (1) outside the system on the positive side (above the ULTP); (2) outside on the negative side (below the LLTP); and (3) within the limits of differences ascribed to the system (between the ULTP and the LLTP). Those in Category 1 may deserve recognition. If a faculty member continues to do superior work relative to his or her peers through at least seven successive time periods,⁵ administrators may safely conclude that he or she is indeed superior. One can logically predict, based on process variation analysis that such a teacher will perform well in the future. He or she could become a model and mentor for other faculty members. Excellent performance (well above the av-

erage; above the ULTP line) needs to be identified, understood, and perhaps used to help the other teachers raise the process average to achieve continual improvement for the department or the school.

Faculty members who are on the low end of the system will require individualized help. An administrator should spend time with each one to find out what kind of assistance they need. For some, it may be additional training. For others, it may be counseling to help restore confidence and enhance performance. For a few, it may be an offer to move to a more suitable position within the organization or elsewhere. Or perhaps they just need a trip to the doctor (e.g., physician, optician, or dentist) for a checkup and treatment.

In conclusion, then, based on process variation analysis,

Although common-cause variation is inherent in any process, it is still possible to reduce it (which is, of course, the goal of long-term improvement) by redesigning the service, employing better technology, or providing extra training for those who participate in the process.

administrators should not rank teachers whose performance falls within the control limits of differences attributable to the system. Differences between members of this group arise almost entirely from the actions of the system, not from the teachers themselves, and are usually meaningless. Statistically speaking, there is no evidence that the teacher with the highest rating in this group will perform better than the one with the lowest rating.

So how should the administration deal with these teachers? A good administrator will seek to improve the system in which teachers work in order to accomplish ever greater consistency of performance so that even these apparent differences continually diminish.

It is important that administrators understand the difference between common causes and special causes of variation. Failure to do so can be very costly to the institution. To react to an outcome as if it came from a special cause, when in fact it comes from a common cause, amounts to tampering with a stable system. On the other hand, to treat an outcome as if it came from a common cause, when in fact it comes from a special cause, is to miss the opportunity to stabilize and improve the system. When the system is the major cause of the problems, as is most often the case, changing it can produce improvement. Because of their scope of authority, the administrators are able to make alterations in the system. That is their responsibility. It is also their responsibility to look ahead, predict necessary changes in the services offered, and keep the institution operating smoothly.

Thus, administrators will do well to engage everyone, teachers and staff included, in the quality transformation.

Employees will eagerly participate if they understand this new approach and what the changes will mean to each of them. One way to accomplish this is to provide ample time for group discussions within the context of a trusting, open environment where everyone can express his or her views without fear of reprisal either from the administrators or from their colleagues.

Plan, Do, Study, Act

At the individual level, each teacher can become involved in the never-ending institution-wide process of continuous improvement using the PDSA (Plan, Do, Study, Act) cycle.⁶

Plan - Develop an action plan to improve classroom processes by first reviewing the school's mission and goals; then ascertaining the exact nature of the problem; and finally, seeking possible solutions.

Do - Get employees on board to carry out the plan by showing everyone (teachers, parents, students, and constituents) where changes will be made, and then implementing them.

Study - Determine whether the changes have produced the desired results.

Act - Use the information obtained to alter and improve the process. Repeat.

This cyclical process can be very helpful in the academic processes of syllabus planning, construction, and classroom implementation, and can be done each quarter, semester, or year. Classroom processes can be continually improved by incorporating into syllabus preparation input from past training and experiences as well as contributions from various sources: students, peers, administrators, parents, conferences, journals, and many others. Driving out fear and engaging everyone in the quality transformation will go a long way toward helping every employee, and especially teachers, to experience joy in their work.

Optimizing the Aim of the System

A system may be defined as a "network of interdependent components that work together to accomplish the aim of the system."⁷ Only if the components work together well

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will the system be effective. The elements must be clear to everyone in the organization and must include plans for the future (e.g., constant scanning of the environment to determine the need for new services, innovations, or methods) for “where there is no vision, the people perish” (Proverbs 29:18, KJV). It is the administration’s responsibility to optimize the aim of the system, that is, to coordinate the efforts of all components to achieve the institution’s stated goals. Anything less will bring eventual loss to every component. School administrators must understand the interrelationships among the components and the people who work in the institution.

Many factors in an educational system affect the individual teacher’s performance. These include the training each one has received, the amount of work and nature of tasks performed, the information and resources provided, the type and number of students taught, the type and number of people worked with, the leadership exhibited by supervisors and administrators, everyday disruptions on the job, the fairness of management policies and practices, and other environmental conditions (e.g., noise, low morale, poor food in the school cafeteria). Few performance evaluations recognize such factors, often placing the blame on individuals who have little control over their environment. Pitting individuals or departments or schools against each other for resources or for rewards is destructive for an educational institution, as it encourages people to focus on maximizing their own expected gain, not the betterment of the institution. Similarly, in such a stress-filled environment, performance targets or arbitrary cost-reduction goals will not motivate anyone to improve the system or customer satisfaction; these employees will act only to meet their own goals or targets at the expense of the institution.

Achieving an Optimized System

A classic example of an optimized system is a world-acclaimed orchestra. Its players do not attempt to play solos or become prima donnas who try to draw attention to themselves. They are there to support one another. A good orchestra is judged not by the number of its brilliant players but by how well everybody works together. The conductor coordinates and offers direction, soliciting the cooperation of all players to achieve the stated aim of the system: to deliver a quality musical performance. If a player attempts to make a mark for himself or herself without regard to how this might impact the other players, the quality of the overall performance will be ruined.

Each component of a system has the obligation to contribute its best to the system, not to maximize its own operation as a profit center. From a global perspective, it is even possible for some parts to operate at a loss in order to optimize the system, including the components that take a loss. This concept is sometimes hard to understand—for everyone to gain, the aim of the overall system must be optimized, not the individual components. Performance evaluations that treat individual components in the school as profit centers

or that reward or punish the outcomes of individual performance without regard to the interrelationships among the system’s components and the people who work in it, seriously impede the success of the overall system.

Conclusion

Many questionable practices in educational institutions arise from failure to understand the difference between common causes and special causes of variation. A proper understanding of process variation will help administrators understand which problems are attributable to the system and which are attributable to special causes. People should not be ranked or judged, as this does not help them do a better job. Instead, the administration should manage the institution so that the function of every component (schools, colleges, departments, etc.) contributes to the optimization of the system. It should encourage communication and cooperation among components and give each a chance to take pride in its accomplishments.

The administration should determine which employees need special help, and make sure they receive it. It should not differentiate between the above average and the below average within an acceptable range. Instead, it should actively work to determine the real causes of problems, and then work to eliminate them. A good administrator forgives mistakes and fosters cooperation among institutional components. Most of all, leaders and employees must collaborate to foster the continual development of everyone in the system, in order to better serve both God and society. ✍



Dr. Ben A. Maguad is Associate Professor of Management at Andrews University in Berrien Springs, Michigan. He holds a Ph.D. in Business and Management. The focus of his dissertation was applications of quality management in higher education. He is a senior member of the American Society for Quality and has worked and taught in the Philippines, Thailand, Hong Kong, Trinidad and Tobago, Singapore, Taiwan, and the U.S.A.

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