

**CE**

# The Use of Statistical Control Charts to Monitor and Improve the Management of Education Department Resources

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Educators are responsible for the management of resources. Statistical control charts (SCCs) may be used by educators to improve resource utilization. In this article, the author describes the use of SCCs and presents a case study that demonstrates the power of SCCs to monitor processes and outcomes, to prompt change, and to be used as an effective presentation tool.

Educators are responsible for the management of resources. Appropriate or inappropriate utilization of these resources may influence not only the education department but also the organization (hospital, market, division, or corporation). Management of resources requires the transformation of data into information. Statistical control charts (SCCs) are simple tools that transform data into information. They may be used by educators to improve performance and minimize variation.

## STATISTICAL CONTROL CHARTS

Statistical control charts are used to display performance data over time (see Figure 1). The performance data may be representative of a process or an outcome. Examples of educational processes include the number of unplanned participants in a nursing orientation program and the length of time needed to complete departmental orientation. Examples of educational outcomes include the number of participants who

successfully completed an educational program and the cost per participant for an educational program. There are several different types of SCCs. The type of SCC used depends on what is being measured (attributes or variables), how it is being measured (raw number, percentage, or rate), and the sample size. Statistical control charts have three main components: a line representing the performance data over time, a line representing the mathematical average (mean), and lines representing control limits above and below the mathematical average (upper and lower control limits [UCL and LCL, respectively]). Statistical control charts may have one or more UCLs and LCLs.

As the performance data move across the mean and the UCL and LCL of the chart, information emerges. First, SCCs should be evaluated for patterns (cyclic and seasonal) and trends (upward and downward). Second, SCCs should be evaluated for predetermined criteria that indicate that further investigation is required. Statistical control charts that do not meet predetermined criteria for further investigation are stable or in control. However, just because a process or outcome is stable does not mean that there is no room for improvement. There may be elements or steps within the process that can be improved to reduce variation (common-cause variation). Statistical control charts that do meet the predetermined criteria for further investigation are unstable or out of control. Processes

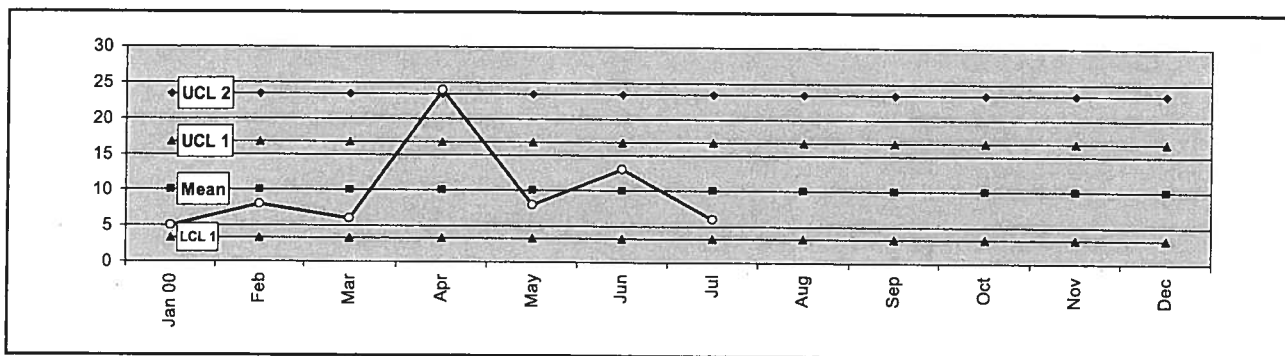
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The following information is based on personal experience. Please see the list of suggested readings at the end of the article.

The author has disclosed that she has no significant relationships with, or financial interest in, any commercial companies pertaining to this educational activity.

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**FIGURE 1** Lost Basic Life Support: Health Care Provider Training Renewal Spots 2000—Raw Number (Down Is a Good Thing!). This figure demonstrates 7 months worth the data points.

or outcomes that are unstable or out of control should be investigated further by using methods to determine the cause of the variation (special-cause variation). These methods include, but are not limited to, brainstorming, creating cause-and-effect diagrams, and collecting and analyzing information on a specific component or step within the process or outcome. By using these methods, the special-cause variation noted within processes and outcomes may be attributed to subjects (e.g., patients and class participants), staff members (e.g., patient care and education department), the organization, the environment, or random factors, and plans for improvement may be developed and implemented.

Processes or outcomes that are unstable or out of control may be moving in a desirable or an undesirable direction. Both should be investigated. If the direction is desirable, then the method used to determine the cause of the variation will indicate factors that should be maximized to achieve improved performance. If the direction is undesirable, then the method used to determine the cause of the variation will indicate factors that should be eliminated or minimized to achieve improved performance.

Thus, the obvious question is this, "Why not use a column or line chart to display performance data over time?" Column and line charts are easy to create and analyze. They may be created by using basic computer programs found in most operating systems (Microsoft Excel Wizard Function). Like SCCs, column and line charts display performance data over time. They are also used to analyze patterns and trends and identify outliers. Unlike SCCs, column and line charts do not have interpretation guidelines that may be used to determine if processes and outcomes should be investigated. This is an important addition to common methods used to monitor education department activities. Education staff members are busy and should have access to tools that help them not only monitor processes and outcomes but also set priorities for and prompt improvement. In short, SCCs indicate when

action should be taken to investigate and/or improve processes and outcomes.

### CREATING A SIMPLE SCC

There are many software packages (SCC and performance improvement) that may be purchased to create and analyze performance data. Because this article is about resource utilization, an appropriate use of resources would be to contact the quality department within the organization to determine if they have recommendations for SCCs and interpretation guidelines. Statistical control charts and interpretation guideline preferences may vary according to organization. Many quality departments have control chart and performance improvement software packages available for use by other departments within the organization.

Simple SCCs are easy to create and analyze. They may be created by using basic computer programs found in most operating systems (Microsoft Excel Wizard Function). Inexperienced Microsoft Excel users may find it easier to periodically adjust the mathematical average, the UCL, and the LCL as data are added to the sample. Experienced Microsoft Excel users may find it easier to build formulas to calculate and change the mathematical average, the UCL, and the LCL automatically as data are added to the sample. The instructions in this article were written for the inexperienced Microsoft Excel user and direct the creation of the most basic SCC for frequency counts with raw numbers (see Table 1).

### DETERMINING SIMPLE STATISTICAL CONTROL PATTERNS THAT REQUIRE INVESTIGATION

The following statistical control interpretation guidelines were used during the development of this article (see Table 4). Statistical control charts should be read

**TABLE 1**

**Creating a Statistical Control Chart (SCC)**

- Collect performance data (e.g., cost, encounters, participants) for at least seven units of measurement (e.g., days, weeks, months).
- Calculate the mean and standard deviation of the performance data.
- Determine the upper control limits (UCL) and the lower control limits (LCL; see Table 2)
  - UCL 1 = mean + (1 × SD)
  - UCL 2 = mean + (2 × SD)
  - LCL 1 = mean – (1 × SD)
  - LCL 2 = mean – (2 × SD)
- Use an Excel Spreadsheet to plot the performance data, mean, and control limits as data lines (see Table 3).
- Create the SCC by using the Line Chart option in the Excel Chart Wizard Function (see Figure 2).

**Note.** The smaller the level of measurement, the quicker the sample size will grow. Units of measurement should be represented on the horizontal, or x, axis and performance should be represented on the vertical, or y, axis. Some LCL 2s may not be visible because their value is less than zero.

from left to right. Each guideline should be applied to the data points to determine patterns, trends, and whether the process is stable (in control) or unstable (out of control) and requires further investigation. As data points are added over time, the mean and control limits will change, leading to pattern, trend, and criteria changes (see Figures 1 and 4). Therefore, each time new data are added and the mean and control limits are adjusted, the last 7 to 14 data points within the SCC should be systematically reanalyzed. For this reason, it is important to save the Excel workbook by title and date to maintain a record of performance (baseline and subsequent versions).

In addition to analyzing SCCs for patterns, trends, and criteria that indicate that further investigation is needed, education department staff members may set goals or establish thresholds for processes and outcomes. The goals and thresholds, for the sake of simplicity, are typically not represented on the SCC itself but may be written into the header or footer and/or may be shared verbally with target audiences.

**STRATEGIES FOR USING SIMPLE SCCS DURING PRESENTATIONS**

Statistical control charts are effective and simple tools that may be used to present process and outcome information. As with all presentations, the first element

of preparation is to consider the target audience. The target audience’s knowledge level of SCCs and the process and/or outcome under investigation is paramount to their understanding of and participation in process improvement. The second element of preparation to consider is the creation and visual presentation of the SCC (see Table 5).

**CASE STUDY: BASIC LIFE SUPPORT: HEALTH CARE PROVIDER RENEWAL TRAINING SLOTS**

Basic Life Support: Health Care Provider (BLS HCP) is required of most clinical staff members at one health-care organization. If BLS HCP is listed as a requirement as per the job description or departmental or hospital policy, and it is allowed to expire, the staff member will not be allowed to work and will face corrective actions. This carries implications for the clinical staff member (self-esteem, job security, and personal financial obligations) and the staff member’s patient care department, the education department, and the organization.

The status of BLS HCP must be renewed every 2 years. The provider class typically runs 6 hours in

**TABLE 2**

**Sample Data**

January	5
February	8
March	6
April	24
May	8
June	13
July	6
August	16
September	4
October	6
November	3
December	5
Mean	8.67
SD	6.11
UCL 1 = mean + (1 × SD)	14.78
UCL 2 = mean + (2 × SD)	20.89
LCL 1 = mean – (1 × SD)	2.56
LCL 2 = mean – (2 × SD)	–3.55

**Note.** UCL = upper control limit; LCL = lower control limit.

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**TABLE 3 Sample Excel Spreadsheet Setup**

	A	B	C	D	E	F	G
1		UCL 2	UCL 1	Data	Mean	LCL 1	LCL 2
2	January	20.89	14.78	5	8.67	2.56	-3.55
3	February	20.89	14.78	8	8.67	2.56	-3.55
4	March	20.89	14.78	6	8.67	2.56	-3.55
5	April	20.89	14.78	24	8.67	2.56	-3.55
6	May	20.89	14.78	8	8.67	2.56	-3.55
7	June	20.89	14.78	13	8.67	2.56	-3.55
8	July	20.89	14.78	6	8.67	2.56	-3.55
9	August	20.89	14.78	16	8.67	2.56	-3.55
10	September	20.89	14.78	4	8.67	2.56	-3.55
11	October	20.89	14.78	6	8.67	2.56	-3.55
12	November	20.89	14.78	3	8.67	2.56	-3.55
13	December	20.89	14.78	5	8.67	2.56	-3.55

Note. UCL = upper control limit; LCL = lower control limit.

length, and the provider renewal class typically runs 2 hours in length. Expired BLS HCP cards are not recognized and necessitate completion of the 6-hour provider class. On average, the healthcare facility retains 1,825 clinical staff members. BLS HCP instructors consist of nine designated instructors from the education department and limited internal facility (other department) and external contracted instructors. At the organization, effective and efficient resource utilization is key to meeting the demand for BLS HCP training.

In April 2000, the education department had 24 lost BLS HCP Renewal (BLS HCPR) training slots. At the same time, staff members and managers complained that there were not enough training slots to meet training needs. Education department staff members stated that it was an issue of improper resource utilization. Clinical and nonclinical staff members and their managers stated that it was an issue of unmet supply and demand. Dissatisfaction was at an all time high.

Lost BLS HCPR training slots are defined as those training slots lost or wasted because a registered participant did not attend a class (no call-no show) or did not cancel the registration in a timely manner, at least 10 business days prior to the first day of class (inappropriate cancellation). The end result of no call-no shows and inappropriate cancellations is twofold: (1) The lost BLS HCPR training slots may

not be transferred to other organizational staff members (training slot utilization) or sold to the community (revenue-producing activity) because of preparation and scheduling issues; and (2) the lost BLS HCPR training slots negatively affect the resource utilization (equipment, financial, human [staffing and scheduling], and material) and productivity of the patient

**TABLE 4 Statistical Control Chart Interpretation Guidelines That Require Further Investigation**

- Seven or more points in a row on one side above or below mean
- Seven or more points in a row in an upward or downward trend
- Fourteen or more points in a row alternating up and down
- Three or more points in a row between the mean and the UCL 1 or the LCL 1
- Two or more points in a row between the UCL 1 and UCL 2 or the LCL 1 and LCL 2
- One or more points in a row outside the control limits (above UCL 2 or below LCL 2)

Note. UCL = upper control limits; LCL = lower control limits.

**TABLE 5**

**Elements of Presentation Preparation**

Target audience

Knowledge level of statistical control charts

- Purpose
- Interpretation guidelines

Knowledge level of process or outcome

- What is being monitored
- Why it is being monitored
- How it is being monitored
  - Type of data collected (raw number, percentage, or rate)
  - How data are displayed (desired outcome or undesired outcome)
  - Date collection methods (brief overview)
- What is the goal
- What are the findings
- What are the next steps (process improvement)

The statistical control chart

Detail

- Simplicity (basic information)
- Color scheme (primary colors)
- Size (consider room and audiovisual equipment available)

Interpretation

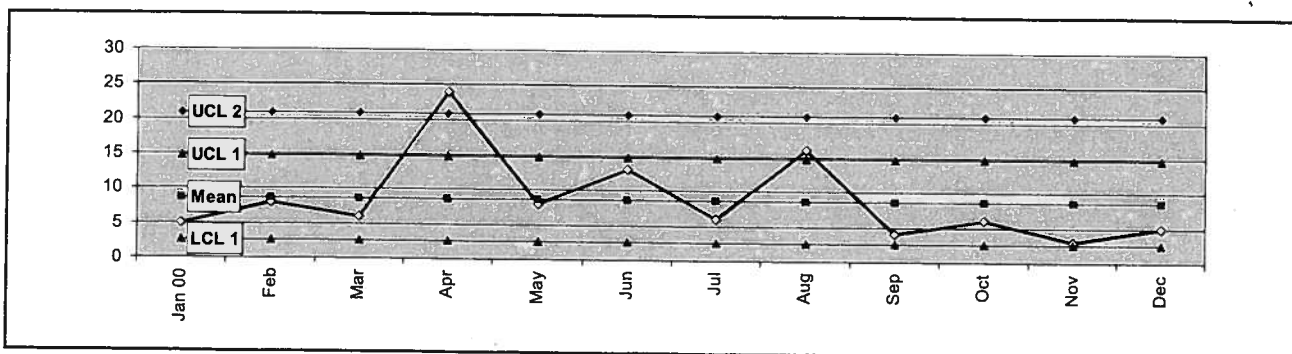
- Type of data (raw number, percentage, or rate)
- Clues (desired outcome; e.g., "up is a good thing")

care department, the education department, and the organization. The education department began collecting data on lost BLS HCPR training slots and using methods to determine the cause of the variance with

staff members and managers as well as the cause of no call—no shows and inappropriate cancellations.

Data collection for the first 7 months of 2000 on lost BLS HCPR training slots indicated that the process was out of control (see Figure 1). The April 2000 data point was above UCL 2. Between April and June 2000, the education department learned that staff members were most commonly no call—no shows because they had not been scheduled out of staffing by the managers (communication) and were most commonly inappropriate cancellations because they were not able to obtain their training materials, either in a timely fashion or at all (departmental availability of training materials). The registration process was improved by including the manager's signature on the registration form to ensure that the staff member would be scheduled out of staffing to attend the class. The registration process was also improved by increasing the par levels of BLS HCP training materials on the patient care departments to ensure the availability of training materials for class preparation. Staff members and managers were educated about the registration process changes. Data collection from August to December 2000 indicated that, with the exception of August 2000, lost BLS HCPR training slots decreased. Between September and December 2000, the data points were between the mean and the LCL 1 and were in a desirable direction. Generally speaking, the process and the outcome were improving (see Figure 2).

However, between February and June 2001, lost BLS HCPR training slots increased. The June 2001 data point was above UCL 2, and there were 14 or more points in a row alternating up and down (see Figure 3). Lost BLS HCPR training slot performance was again out of control. Methods to determine the cause of the variation were again used with staff members and managers. The registration process was again improved. Confirmation notices were sent to the managers in addition to those already being sent to staff members, and 2-week reminders were sent to the staff members and the managers (communication).



**FIGURE 2** Lost Basic Life Support: Health Care Provider Training Renewal Spots 2000—Row Number (Down Is a Good Thing!). This figure demonstrates 12 months worth the data points.

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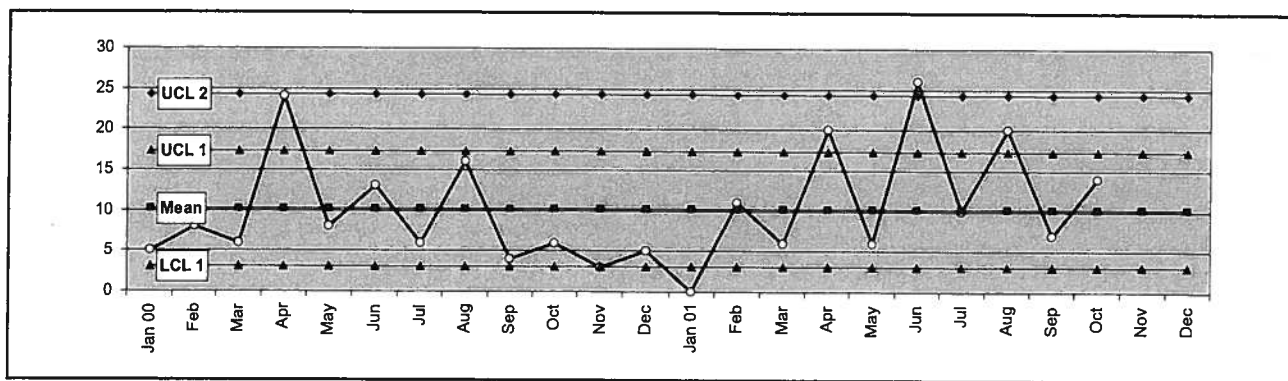
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**FIGURE 3** Lost Basic Life Support: Health Care Provider Training Renewal Spots 2000 and 2001—Raw Number (Down Is a Good Thing!).

From July to October 2001, although lost BLS HCPR training slots decreased, they varied between 7 and 20 per month and alternated 14 or more points in a row up and down (see Figure 3).

The impact of lost BLS HCPR training slots to the patient care departments and the organization as a whole was incalculable. The impact of lost BLS HCPR training slots to the education department in lost revenue alone was estimated to be \$3,120 in 2000 and \$3,600 for the first 10 months in 2001 (lost revenue calculated by multiplying the community cost for BLS HCPR by the total number of lost BLS HCPR training slots). The SCCs (lost BLS HCPR training slots and lost BLS HCPR training slot revenue) were presented to the chief nurse officer and the nurse managers at the November 2001 Nurse Leadership Group meeting. The recommendation was made to charge departments the community cost for the BLS HCPR course in cases where no show–no call and inappropriate cancellation decisions were upheld after an appeal process. The outcome of the recommendation was immediate and long lasting (see Figure 4). Although the goal of the education department is to never have any lost BLS HCPR training slots, the continued trend of

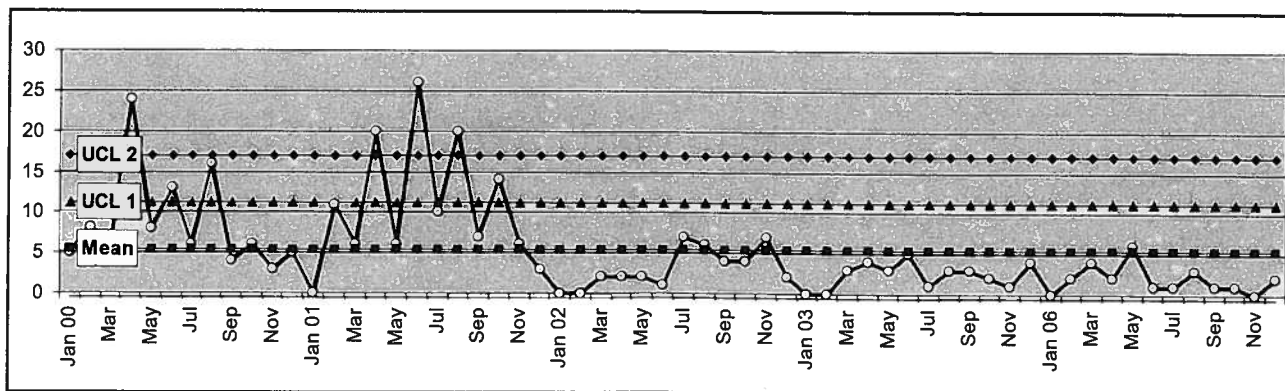
data points falling between the mean and the LCL 1, because it is in a desirable direction, is acceptable.

### CONCLUSION

Educators are responsible for the management of resources. Use of resources by education departments may adversely affect the productivity of the organization. Management of resources requires the transformation of data into information. Statistical control charts are tools that transform data into information. They may be used by educators to monitor processes and outcomes and set priorities for and prompt change. They are easy to create and may be used as an effective presentation tool to graphically display information for audiences. The SCC is one of many performance improvement tools and techniques that may be used to improve performance and minimize variation in processes and outcomes managed by the education department.

### ACKNOWLEDGMENTS

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**FIGURE 4** Lost Basic Life Support: Health Care Provider Training Renewal Spots 2000–2003 and 2006—Raw Number (Down Is a Good Thing!).

