Applying Six Sigma to Workplace Training

Learning professionals know to always keep an eye on the bottom line. Using Six Sigma methodology can bolster your case for training and eliminate excess expenses.

In 2008, the United States spent an estimated $134 billion on employee training. Employers train employees for improving job skills, career advancement, industry certifications, and the quality of life of their employees, among other reasons. Employers presume a return on their investment in the form of more qualified employees or employees with a more positive attitude toward their job and organization. The last thing an employer wants is to spend money that does not result in some benefit for him.

The bottom line
The American Society for Training and Development (ASTD) reported in 2008 that, on average, employers spent more than $1,000 per employee for training—not accounting for time lost in training. Employers certainly have embraced the need for employee training with such an expenditure.
However, according to a study on retention in *The Journal of Economic Education*, the annual rate of retention loss of material learned averages between 13 to 23 percent. In other words, American employers are throwing away between $17 and $30 billion a year on unused or lost training. Reasons abound for this retention loss, ranging from lack of use of the material learned to interference effects from other material learned, to inappropriate instruction for the tasks at hand.

In this article, we examine one way to alleviate some of this retention loss and, thus, some of the resulting economic loss by aligning training with need: the identification of the knowledge, skills, and abilities (KSAs) used and reinforced by the targeted job (TJ) and, as important, the identification of the expected KSAs used by operators in the subsequent job (SI) in the production flow. This focus concentrates training on that which is necessary, used, and reinforced, thereby reducing over-training or unused or inappropriate training.

Achieving an efficient and directed training program requires a systematic look at training needs not only from the confines of the job but also relative to the job's interaction and interconnectivity to the SJs. By concentrating on the educational process, one changes the focus from training for the job to educating for the job requirements according to corporate workforce needs. This shift allows the training department to transform workers from mere job operators or spectators (TJOs or SJOs) to workers involved with the real business of their jobs. This new focus also transforms training from a reactive-based approach that examines individual job-related outcomes into a proactive educational approach based on the worker’s acquisition of KSAs. In addition, such a shift identifies those workers who have the necessary—or a significant number of—KSAs for new or expanded jobs as the corporation requires.

**Educational analysis**

Often when asked to re-evaluate the effectiveness of a corporation's training program, the initial reaction is: “We hire good trainers who already examine our training programs to make sure that the needs are all inclusive and cutting edge. Why do we need to go through a further analysis?”

The answer? Because money matters! A failure to match effective training with a structured educational process leads to under- or over-utilization of human and financial capital, also known as waste. Unless the training is intended to supplement the employees’ quality of life, corporate training is an investment and should be measured for its on-the-job ROI. This type of training requires a scrutiny of the corporation's educational process.

The following outlines the method for undertaking and analyzing a corporate educational process by examining training needs relative to the job sequence rather than individual job-training process.

**Using Six Sigma for training process evaluation**

One method of conducting a process evaluation is an analysis using Six Sigma principles. Six Sigma fundamentally targets waste measurement and reduction. It can be applied as readily to areas of training and education as any industrial quality control endeavor. To design an appropriate corporate educational analysis and process, the design application Design For Six Sigma (DFSS) using the Define-Measure-Analyze-Design-Verify (DMADV) methodology is more appropriate than the traditional Define-Measure-Analyze-Improve-Control (DMAIC) model. Below we unpack each step of the DMADV method.

**Define**

The first step for assessing a corporate education system begins with an analysis by a Six Sigma Black Belt (BB) who facilitates the assessment of the organizational and operational needs by assembling and training a team to incorporate this broader outlook. For example, a training department might say: “We are instituting a new email program on our intranet and need to get everyone training on the new program.” A BB team would say: “We are looking at the educational processes needed within the organization to support the corporation’s communication platform, and we are identifying those elements that are critical to quality (CTQs) to assure successful performance.” At this stage, the analysis occurs through reverse engineering.

To identify the CTQs of a TJ, the analysis begins by regarding the training program (or a process line) within the organization as an educational system. According to Six Sigma principles, the CTQs of a function are defined as important, the identification of the knowledge, skills, and abilities (KSAs) used and retained knowledge.

A prudent Six Sigma analysis by a corporate training program that is based on an educational system review process will prevent unnecessary or redundant training for the trainee and the learning department.

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its customers. Here, the customers of the TJIs, for educational purposes, are the SJOs. To identify the needs of the SJO based on the output of the TJ, the BB team begins by organizing focus groups of the SJOs to identify gaps in the TJO’s output that impair subsequent job quality. The purpose here is not to ascertain the TJO’s level of education but rather to ask the SJOs what additional operations could be performed by the TJO that would improve the SJOs’ performance and quality output and reduce waste. The difference between the TJO’s KSAs and the SJO’s CTQs are TJO’s gaps in learning (GIL). This can be expressed as

CTOsSJO−KSAsTJO = GILsTJO

After identification of the gaps, the BB-led training team meets with the TJIs to elicit the TJIs’ preferences for resolving those gaps. The TJIs’ input is critical for many reasons. First, once a learner understands the need for the prescribed learning, he can participate in making his own training as beneficial as possible. This will result in a greater interest from the TJO inasmuch as he has had input into the training protocol as opposed to a protocol being foisted upon him.

Second, the TJO may well help target the training to embrace only those elements necessary to fill his own GILs. For example, from the TJO’s perspective it makes no sense to send employees to a full day of Microsoft Excel training when they intend to use the program only sporadically and their needs could adequately be met by an intuitive Help program video or one-on-one training. Such targeted training enables TJIs to become active participants in obtaining the help necessary to perform the identified CTQ components.

The workflow process and its component pieces and inputs can be modeled as shown in Figure 1.

Although focus groups are an important source to obtain information about needs, much of what customers really need resists ready identification. According to the article “Hidden Minds” in the Harvard Business Review, up to 95 percent of what a customer (the SJO) wants from a new service or educational program may not be able to be articulated or even identified. Here, the BB brings value to the process. However, the BB who conducts the CTQ analysis needs to dig deeper and not simply rely on a focus group to uncover the real needs of the operators.

To counteract such possible omission of CTQs, a full inventory and analysis of the KSAs for each employee in the workplace should be undertaken. Comprehensive interviews with prior job operators (PJIs), SJOs, and current TJIs reveal a true 360 degree analysis of what the TJIs need.

After facilitating the focus groups analysis, the BB constructs a cause and effect diagram that charts the causes that lead to an outcome. Coupling this chart to the information gleaned from the focus groups, the BB identifies the hurdles to the resolution of job completion or improvement with a visual display that identifies those impediments that prevent employees from being fully effective.

After the CTQs are identified and barriers exposed, the BB team must lead the original focus group through a ranking of the GILs. The ranked GILs will form the basis of the learning model needed for the TJIs to fulfill their job needs and deliver the CTQs for the SJOs.

After ranking the GILs, the focus turns to the identification of learning programs that have the capability to fulfill the GILs by teaching those KSAs that reinforce the CTQs. In the same way the operator has been evaluated to determine what KSAs are present or lacking, a training program is evaluated to determine what KSAs it can deliver so that the training will match the GILS without excess or redundant training. Simply put, training programs need analysis to identify the KSAs instilled by a potential training program.

Take the Microsoft Excel training example: The KSAs delivered in Excel training enable an operator to create a spreadsheet or perform functions within that Excel program. The KSAs of this software program provide

Knowledge
• to work on a table/grid environment
• to identify columns and rows
• to identify cell addresses in a table

Skills
• to use the up and down and left and right buttons on a computer
• to use the page up and page down keys
• to increase dexterity

Abilities
• to enable the user to add a column of numbers
• to enable the user to perform statistical functions
• to enable the user to perform mathematical calculations.

Consider a situation in which an operator, working for a custom parts manufacturer, requires training to perform a machining operation for a pre-determined number of parts per order for a company. The operator must, as part of his job, select the correct amount of rough-sized material from the material stock. The drawing identifies the length and width of the object to be machined. In addition, the drawing notes state that the part will best fit on the material stock diagonally.

To ascertain the length of the stock needed to produce these parts, the first step is to determine the maximum diagonal distance between the two farthest points, or in geometric terms, the hypotenuse of the triangle of the length and the width of the material. To do this, one must calculate a square root. Thus, one of the CTQs for this particular machining operation is the identification and calculation of square roots. The operator will perform the calculation using Excel.

In our example, the relevant training question is: “Must the operator sit through a full day of Excel training to learn this relevant job operation or is that employee better served by a truncated, targeted training of Excel?” Conducting such a detailed CTQ and KSA identification for every operation and every operator or employee may not be justified by a comprehensive cost-benefit analysis in every situation, but when training dollars are tight, a closer
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scruity to match needs with training benefits the bottom line. Thus, by defining the CTQs of the job task, the KSAs of the operators, and the GILs the BB team is ready to begin assessment of the new training protocols.

Measure
The next step in the DFSS methodology, the measure phase, validates the metrics for the new process. This phase has two applications: the measurement of the CTQs and KSAs of the internal training, and the establishment of outcomes measurement metrics of the pre- and post-solution analysis to measure the impact of the training process.

The internal metrics are those measurements that correlate the CTQs of the job to the KSAs delivered by the training program. One such method is to identify the KSAs integral to various training programs and compare them to the CTQs required. This correlation is accomplished using a KSA/CTQ matrix. The goal is to identify those available training programs that can train the highest number of relevant KSAs and hence fulfill the greatest number of CTQs. The program that delivers the highest number of KSAs required for a particular job distinguishes itself as the most effective training protocol for that position.

Another method used by the BB team and the focus groups is to rate KSAs quantitatively by which both trainers and operators rate the most important KSAs or CTQs for a particular job regardless of frequency. This process identifies the most important features through the use of weighted measures such as a simple Likert scale. Each plant or operations division will have to evaluate its own CTQs and KSAs in a manner that satisfies the requirements of the operation as well as the needs of the operator or division down the line.

In the second application of the measure phase, the outcome metrics evaluate the impact of the training, typically through a pre- and post-intervention analysis. This includes assessment and testing, measurements regarding retention over time, accuracy of calculations, increase in part quality, and so forth. Outcome metrics vary depending on the character of the outcome as well as suitability or fit of a particular metric methodology.

Analyze
After establishing the measurements of the KSAs, CTQs, and GILs, the next step is the development of a training program with all three of these parameters in mind. Developing a training program that satisfies these parameters will allow a trainer to drill down to include only necessary training and to discard the unnecessary over-training. At this stage it is important to distinguish CTQs or KSAs that are already known by the operators but may not be proficiently used or mastered from these that are unknown to best match the training needs. The operator already may have the KSAs to perform the CTQs but may not be proficient in their use. Knowledge without proficiency can result in GILs, but in such a case a refresher or remediation program, rather than new training, may be the better choice.

At this stage, the BB team will analyze the design feature needs of the training. One method for establishing or ordering the CTQs, KSAs, and GILs is the creation of a customer demand model (CDM) in which CTQs correlate to demands. After indentifying and prioritizing the demands and the KSAs needed to satisfy those demands, the final step is to categorize the KSAs’ characteristics according to learning, retention and use, importance, cost to satisfy, or other relevant grouping categories. Another method for ordering the CTQs (and hence the GILs) is to weight the CTQs and GILs by performing pair-wise comparisons between the CTQs and the demands.

In our earlier Excel example, the CTQ is the need to find the distance between the two points and the KSAs are the necessary knowledge, skills, and abilities of an operator to calculate the resulting square root. At this stage the KSAs inherent to the task are evaluated regarding a learner’s ability to assimilate the KSAs to satisfy this CTQ and relative to the GILs of a particular operator. By comparing the CTQs with the GILs of the operations, the training then can be correlated to only those CTQs that need to be addressed, only those KSAs needed, and in a manner that the TJO will effectively absorb.

Narrowing the range of training KSAs affects choices regarding delivery and asset allocation. For example, if the operators need to identify and calculate a square root, but the corporation does not have the hard assets to supply each operator with a computer, a training program incorporating a simple $4 calculator and a review of the Pythagorean theorem rather than a four-hour Excel or CAD software training may be the most cost-effective method to satisfy the required KSA training and satisfy the CTQ function.

Thus, after the necessary GILs and their hierarchy are established, the BB team is ready to design a training program that best addresses these GILs. This will vary according to the programs that are available, the competency of each trainer with a variety of training protocols, the time required for the training, and the resources of the company.

Design
In the design phase the BB team designs various training programs that can satisfy the established GILs through the use of existing programs, introduction of new programs, or the amalgamation of sections of various stock programs. The BB team develops
the training design using simulation tools to predict CTQ performance, evaluating the iterations and revising the plan until the CTQ predictions meet the training requirements.

By simulating the training effectiveness and introducing a pilot program, the Six Sigma analysis assists in deciding the most cost-effective training within a corporation's budget and avoids waste of financial resources. Here it is necessary to develop multiple avenues to address the GILs by first brainstorming various designs and conducting a focus group with input from the budget owner, narrowing down the various training programs to two or three possible programs and finally settling on the most beneficial and effective program. For training to benefit the corporation, it must enhance productivity and be cost effective and affordable.

Once the pilot meets the demand for training, the BB team must develop an efficient and cost-effective implementation plan. Attention to the budget is critical: A training department not aware of budgetary considerations for its programs may soon become a training department in search of a company!

Verify
The last phase of this process is the verify phase in which the BB and training department verify that the training program has met the necessary GILs for the SJOs’ needs. The BB team does so by developing control plans and metrics and collecting performance data after training. Here the BB team continues to collect and measure the full panoply of metrics, devices, and information gathered through the focus groups, surveys, loss analysis, and so forth to check for failures in training and their effect on operations. The use of any particular evaluation method and metrics are particular to the job operation being monitored.

Use DMADV to maximize training resources
By evaluating industrial training needs through a Six Sigma analysis process of targeted education, waste is eliminated through two channels:

- The reduction in the scope of training to eliminate that which is unnecessary and greater efficiency due to limited remedial training for operators whose KSAs were lost through decay
- Retention loss and the reduction in the amount of training hours that TJOs consume for training.

As jobs become more complex, they will require a larger repertoire of KSAs.

Through targeted training, operators will build an inventory of established, applied, and retained knowledge. A prudent Six Sigma analysis by a corporate training program that is based on an educational system review process will prevent unnecessary or redundant training for the trainee and the learning department.

Training departments need to evaluate corporate needs primarily from the eye of the customer, rather than the viewpoint of the trainer. Excess or unrelated training leads to boredom, loss of retention, and financial waste, and does not maximize the human capital resources of the corporation. T+D

**Figure 1 | KSAs/CTQs & JOB IDENTIFICATION LOOP**

- **KSAs delivered by Training**
  - PJ
  - PJ
- **KSAs delivered by Training**
  - TJO
  - TJ
- **KSAs delivered by Training**
  - SJO
  - SJ

**KSAs/CTQs of Job**

**BEGINNING OF WORK PROCESS**

**OUTPUT OF WORK PROCESS**

**WORK FLOW**

**KSA/CTQ FEEDBACK**

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