Training as Part of a Laboratory Quality Control Program

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Abstract
Analyses consist of two parts, the analyzer, and the analyst. Each part is of equal importance in producing quality analytical results. As lab workers, we expend much time and effort on quality control programs to make sure our analyzers work properly. Why don’t we expend time and money on analyst quality control programs as well? Analyst mistakes can be costly, as will be illustrated with several anecdotes. To keep from making mistakes, analysts need the right information to do their job properly. The key to getting analysts the information they need is training. In this article the case is made that the training of laboratory personnel is an important part of any lab’s quality control program. After dispelling some of the myths that surround training, the ways to determine your lab’s training needs are discussed. This revolves around developing a training plan. The advantage of training for the analyst and the amount of money that should be budgeted for training are also addressed. The types of training available, and their advantages and disadvantages will be discussed in a subsequent article.

I. An Overview of Analyses
Although there are many different types of analytical labs in the world, almost all of them perform analyses on samples of some kind using instruments of some sort. The point of performing any analysis is to obtain information about a sample. In general, the information is not obtained just to be filed away, but is obtained so that decisions can be made. The decisions being made vary but can include whether to accept a shipment of raw material, adjust a process, or diagnose an illness. The quality of the information derived from an analysis is vital. Bad information leads to bad decisions. We will discover below the consequences of decisions based on bad information.

To perform an analysis, two important ingredients are necessary. First, there is the analyzer. This is the instrument, machine, or device that is used to obtain the needed information. An analyzer can be a chromatograph, spectrometer, analytical balance, or other type of device. The second part of the analysis is the analyst. This is the person performing the analysis, the human being who runs the analyzer to obtain the results. The analyst is important because if they do not do their job properly, the analysis will be incorrect. We can summarize this simple idea in the following equation

Analyzer + Analyst = Results (1)
Given that the analyzer and analyst both appear in equation 1, they are equally important. Analyses cannot be performed without the equipment to do the work. Additionally, analyses can not be performed without trained people who know how to use the analyzer properly.

Many labs have quality control programs in place to make sure their analyzers produce the correct data. These programs can include calibration checks, running diagnostic tests, and the routine replacement of instrument parts. Many hours and thousands of dollars are invested in the laudable goal of making sure analyzers work properly. But what about the analyst? Does your lab have a quality control program to make sure the analysts are working properly? What is the risk of not having such a program? The cost of poorly performed analyses can be staggering as noted in the following four anecdotes. These stories are culled from my two decades of experience as an analytical lab consultant, trainer, and worker.

1.) At an industrial quality control lab, an HPLC test was used to accept shipment of a raw material. Shipment after shipment of the material was rejected because the liquid chromatogram of the material had a “split” peak that did not meet specifications. However, each shipment passed the vendor’s tests with flying colors. Manufacture of an important product was held up for several months due to lack of this raw material. Relations with the vendor also hit rock bottom as a result of their having to absorb the cost of shipping many tons of material back and forth. Investigation showed that overloading of the HPLC column caused the “split” peak. Injecting $1/10$th the amount of sample normally injected caused the “split” peak to disappear, and gave a normal looking chromatogram that met specifications. Manufacture of product was resumed, and vendor relations improved greatly. The total cost of not being able to make and sell an important product for several months was hundreds of thousands of dollars.

2.) An analytical lab was trying to develop a quantitative method using spectroscopy to measure the concentration of a molecule in a new product. Hundreds of man-hours were expended trying to achieve a reproducible, accurate calibration, a goal that was not achieved. Manufacture of the product was delayed for several months until some way of measuring the molecule’s concentration in the product was found. Investigation showed that the pathlength of the samples was not well controlled, causing large variations in the spectroscopic absorbances measured. Beer’s law states that sample pathlength must be controlled to achieve reproducible absorbances in quantitative spectroscopic analyses. A change in sample preparation method gave samples of controlled pathlength. A usable calibration was quickly achieved, and manufacture of the product began. The cost of the delay in product introduction, though difficult to calculate, was probably considerable.

3.) The R&D department at a company spent $150,000 on a new spectrometer system to analyze for an important molecule that was present at low concentration in their products. They also hired a Ph.D. scientist and a technician to work on the project. After 6 months of work they were not able to produce a reliable method of quantifying the amount of analyte in their product. Investigation showed that the amount of analyte present in samples was orders of magnitude less than the minimum amount the
instrument could detect. The instrument was abandoned, and the workers were re-assigned. $150,000 of scarce capital equipment funds were wasted, as well as a person year of time.

4.) This anecdote is from my own personal experience. Very early on in my career I worked as a lab technician for a well known industrial research lab. The department spent $40,000 on what was then a new type of instrument, an FTIR. I was appointed to learn how to use the instrument. I poured over the technical documentation for the instrument, and read textbooks, but never got fully comfortable with running the instrument. The instrument vendor offered a free 1-week training course on the instrument at their headquarters. I asked my department head for $1000 for travel expenses so I could take the training course. He refused, citing the lack of funds in the travel & training budget. I struggled on, and finally did learn how to use the instrument in a rudimentary way. However, I spent hundreds of hours of company time teaching myself the basics, and was never able to fully utilize the companies $40,000 investment. A $1000 investment in travel could have prevented thousands of dollars of wasted company time.

I’m sure every lab worker and manager has experienced or heard of horror stories like these. The analysts in these stories were making sincere attempts to do their jobs to the best of their abilities. They were not incompetent, simply inadequately prepared. Analytical mistakes can occur in any lab. Analysis mistakes can cost your company thousands or even millions of dollars. Can you afford to continue to make these kinds of mistakes? The real problem is how do we get analysts the information they need to do their jobs properly? The answer is training. This tried and true method of transferring information from an expert to a non-expert is still the best way of making sure your analysts have the information they need to do their jobs properly.

How might training have saved the companies discussed above? In the first anecdote, the HPLC method did not specify the amount of sample to inject. Each analyst who ran the test injected a different amount. Proper training of the method developer would have insured the standard operating procedure contained a specification for the amount of sample to inject. In the second anecdote the people developing the calibration were unfamiliar with Beer’s Law. The simplest type of spectroscopic quantitative analysis training would have taken care of this problem. In the third anecdote the workers failed to determine the minimum detection level for their analyte before purchasing the instrument. A training course on the fundamentals of spectroscopy taken prior to purchasing the equipment would have solved the problem. In the last anecdote, a simple investment of $1000 would have allowed me to do a better job at FTIR analysis, and the hundreds of hours I spent trying to figure out how to do things on my own would have been spent on more productive pursuits. If training can avoid these problems, why are lab managers hesitant to spend money on training their workers?

II. Why Companies Don’t Train Their Analysts

I have heard many arguments made against the need for training. However, upon thoughtful examination of these arguments, I do not believe they hold water. I refer to
these arguments as *training myths*. Here is my response to four common training myths.

1.) **Cost**
Some people think training courses are expensive, and may feel that a lab’s money may be better spent elsewhere. But keeping the anecdotes above in mind, what is the cost of an improperly performed analysis? From $10,000 to $1 million or possibly even more. Thoroughly training all the people in a lab costs orders of magnitude less than the cost of making bad decisions based on bad information. Money spent on training is preventive medicine; it might be too late for training to solve today’s crisis, but it will guarantee fewer crises in the future.

Some people feel that the daily or hourly rate charged by trainers is inappropriately high. We need to keep the cost paid for trainers in perspective. Self-employed professionals such as lawyers and accountants make their living charging what is a reasonably high hourly rate compared to the hourly wage of the average American. Most trainers are highly educated and experienced, and are self-employed professionals in their own right. Now, if you are staring a tax audit or lawsuit in the eye, the advice of an accountant or lawyer is invaluable compared to what they charge for their services. In my experience scientific trainers do not charge any more per hour than other self-employed professionals. To avoid staring large, expensive problems in the eye, wouldn’t it make sense to invest a comparatively small sum of money in training?

2.) **Time**
Many managers and analysts claim they do not have the time to take a training course. Frequently, these people say they are too busy “putting out fires” to attend. What these people do not realize is that many of the “fires” they are valiantly fighting are caused by improperly performed analyses! Proper training will increase the quality of analyses, and reduce the number of “fires” that have to be put out. Also, it does not take onerous amounts of time to train people. One or two days of training are enough for most workers to get up to speed on the important points of specific types of analysis. If fighting fires is a problem in your lab, then training is your fire extinguisher!

3.) **“We Don’t Need No Stinking Training”**
Some analysts may think that they know all they need to know about their jobs, and may feel they don’t need training. Some managers may think that everything is going along swimmingly in their labs, so why spend money on training? If you are an analyst, training is part of your career development responsibility to yourself. If you already have a set of skills, you still need to take a training course from time to time to hone those skills. If you know everything you need to know to do your job, you should still be learning new skills to expand your job responsibilities. This will make you more valuable to your company, help fatten your paycheck, and I believe make you more attractive for promotions. It also makes you more marketable if you find yourself looking for your “next” job. If nothing else, learning new skills and adding new job responsibilities will make your job more interesting and satisfying.
For the complacent manager, all I can say is just wait. Sooner or later, a problem will crop up in your lab that you will not be prepared for. It may cost lots of money and cause damage to your credibility as a result. It is better to be pro-active and have highly trained people available in case there are problems, rather than being reactive and waiting until there is a catastrophe to take action.

4). Well Trained Employees are More Likely to Leave

The complaint here is that after spending thousands of dollars on training to improve an employee’s skills, the employee will leave for greener pastures taking their skills with them. In a free market economy, employees are always free to quit a job whenever it suits their interest. Any employee is liable to leave any given job at any given time. In theory, well trained employees may leave for greener pastures. However, I have seen no scientific evidence that proves that trained employees are any more likely to leave their jobs than untrained ones. In reality, my experience is that when a company provides training for an employee, the employee appreciates the commitment the company is making on their behalf. Frequently, this commitment is rewarded by increased worker loyalty. Training your personnel may actually increase the likelihood that they stay in their jobs.

III. Training as Part of a Quality Control Program for Analysts

I hope by now I have made it clear how important it is to have well trained analysts in your lab. How do you go about making sure that analysts get the training they need? What labs need is a quality control program for their workers, to make sure the right workers are doing the right job in the right way. Your company’s’ commitment to an Analyst Quality Control program is just as important as its commitment to an Analyzer Quality Control program. Following is a recipe to determine the training that your lab workers need.

1.) Determine What Skills are Needed for Your Analyses

The first step in this process is to assess what actually gets done in your lab. Take a look at what analyses are most important, or get done most often. Then step back and think about what skills are needed to perform those analyses. For example, performing a titration takes different skills than interpreting an infrared spectrum. Make a list of what skills are needed for which analyses, and rank them in importance.

2.) Perform a Skills Assessment of the Lab

Once you know what skills are needed to run the analyses in your lab, you need to discover whether your analysts possess those skills. Interviewing each worker in a lab in what is called a Skills Assessment Interview does this. This interview need not be confrontational. Workers should simply be asked what analyses they are now performing, what their background and experience level is with these analyses, and what they are comfortable and uncomfortable doing. The skill assessment interview is probably best handled by someone from human resources. Input from the worker’s supervisor as to his or her opinion of each worker’s skills is also useful.
3.) Develop a Training Plan to Maintain and Improve the Skills of Each Worker

Once the skills of each analyst have been inventoried, and a list of skills the analyst needs to do their job has been developed, a training plan should be formulated and written down to maintain and increase the skills of the analyst. To develop a training plan you need to ask (and answer) the following questions. When and how will the training take place? How often is training needed? How much should we spend on training? Where will we find a quality vendor to provide the training? Occasional tests of analyst skill are also needed to make sure skills don’t slip. A simple review of result quality or simple observation in the lab can help ascertain this.

4.) Document Progress

Every time a worker is trained it should be recorded in his or her permanent personnel record. Certificates of attendance from formal training courses should be obtained and filed. Written and practical tests of each analyst’s skills should be made, and the results archived. Time spent obtaining informal training from co-workers should also be noted. At an employee’s annual review, the training received should be compared to the training plan. Any deficiencies in comparison to the plan should be made up immediately. If all the training goals have been achieved, a new plan should be developed. Each employee’s training plan should be reviewed and updated annually. A copy of the plan should be given to each employee, and placed in his or her personnel folder. It is then up to management to commit the resources to insure the training plan is implemented.

Who Should Receive Training?

In a word, everyone, from the person who washes the glassware right on up to the lab manager. The idea behind this is that more information is better. The more a person knows about the work they are performing, the better they will perform that work. It is also good lab practice to make sure that several people know how to perform each analysis. In this way, if the “expert” on an analysis is out of work or leaves the company, there are back-up people to fill in quickly. This argues for not only training people in their areas of expertise, but cross training them in other areas to increase their skill set and expand their horizons. Don’t be afraid to challenge your workers. Just because someone may be inexperienced or not possess a college degree does not mean they can’t learn quickly and effectively. In my decade of experience as a trainer, I have been pleased and gratified by the number of people with little formal scientific education who have firmly grasped what I have taught them. Everyone is smart in their own way. If you challenge your workers you may be pleasantly surprised to see them rise to the challenge.

The Importance of Training for the Analyst

For whatever reason, some analysts may balk at the idea of receiving training. They may not want to spend time away from their jobs, may think they don’t need to learn anything new, or may be afraid of classroom settings for fear of looking stupid. To encourage employees to pursue skills improvement, a discussion of how well the training plan was executed should be part of their annual performance review. The
management and the analyst are responsible for making sure the training plan is followed. Employees who aggressively seek to increase their skills should be rewarded. Analysts need to realize that increasing their skills benefits them because it makes them more valuable to their current and any future employers.

How Much should You Spend on Training?

Training seems to be the Rodney Dangerfield of budget line items; it gets no respect. In good times, training is usually one of the smallest expenses in the running of an analytical lab. In bad times, the training budget is the first to be slashed. I believe this is very short sighted. Analytical mistakes by untrained personnel can be just as costly during an economic boom as during a recession. Training budgets are a small percentage of most lab’s overall operating costs. Slashing training budgets only saves a little bit of money in the short run, but can cost plenty of money in the long run if analyses are not performed properly.

There are typically three occasions that call for training. One is when new instrumentation is purchased. By definition the equipment is unfamiliar to the analysts in a lab, and some kind of training will be necessary to get them up to speed on it. The cost of training on a new instrument should be factored into the budget for the purchase of the instrument. I think 10% of the total purchase cost should be budgeted for this purpose. This is a small price to pay to insure the company’s investment in new equipment is realized by having the equipment run properly.

Another time when it is appropriate to consider training lab workers is when there are new hires. Obviously, new people will need to be taught how to do their new jobs. On-the-job training from skilled co-workers should take place immediately, and be ongoing. However, don’t rush into formal training for new hires too soon. Give them 3-6 months to settle into their new jobs, and get their bearings. A new hire is so overwhelmed with information that the skills learned at a formal training course are frequently forgotten. My experience as a trainer has shown me that once a person has the basics of their job under their belt, they retain the information learned during formal training much better, and are in a better position to ask relevant questions of the trainer. New hires should be formally trained, but it must be done at the right point in their careers to be effective.

There is an ongoing training need above and beyond the purchase of new equipment or the hiring of new people. A fixed amount should be budgeted per employee per year to meet their continuing education needs. A common practice is to budget $1000 per worker per year. This is enough money to send one person for two or more days of formal training offsite. Alternatively, pooling this money for several people is enough to bring a professional trainer onsite for several days to teach a customized training course for a group.

Conclusion

I hope I have strongly made the case to lab managers and workers that it is in both their best interests to regularly increase their skills via training. For the manager, increases in information quality and efficiency are sure to result from a training investment. For the analyst, increasing your skills makes you more valuable to present and future employers. The key to an analyst quality control program is development
and adherence to a training plan. Only then can you be assured that the right people are doing the right analyses in the right way.

Dr. Brian C. Smith is founder and Principal of Spectros Associates, a laboratory training and consulting firm. Since 1992, Dr. Smith has trained thousands of lab managers and analysts in his courses, helping them to achieve better analyses through training. He is the author of several popular textbooks on spectroscopy published by CRC Press and Academic Press. He earned his Ph.D. from Dartmouth College. He can be reached at bcsmith@spectros1.com. For more information on Dr. Smith’s courses, go to www.spectros1.com.