# Accelerating Engagement of First-Year Students in Academics: Use of Ideas from Quality Literature

**David A Gray**
**Messiah College**
**Grantham, Pennsylvania**

***Abstract:*** This paper discusses three ideas that stem from concepts in the literature of Quality that combine to promote a more rapid transition of first year engineering students from the high school environment to the academic environment of college. These three ideas are:

1) The student is the primary employee in the academic process,
2) Grade distribution interpreted in the context of control charts provides significant feedback that allows primary employees to evaluate their own process, and
3) The only way to improve the output of a process is to change it, ergo, "If you do not like your grade, change your process."

These three ideas paint a realistic picture of the college enterprise, and provide the students with context that allows them to evaluate their own progress and to make decisions directed toward improvement.

Messiah College's engineering department has long had concern for successful transition of first year students into the academic rigors of our engineering program. Reflecting this concern, we require Introduction to Engineering, a course for learning about engineering and academic success. Over the past several years, we have incorporated the ideas from quality literature discussed here.

A simple drawing of a college's "manufacturing" process can start the discussion. That simple drawing has three boxes with labels as shown in Figure 1.

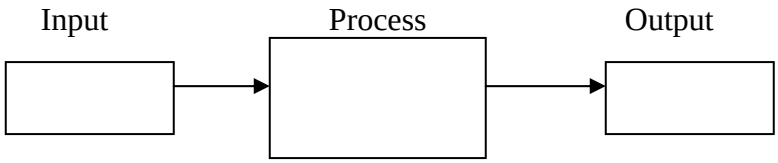


Figure 1: Basic manufacturing process

Allowing students to identify the content of the boxes leads to our second drawing. They recognize that the dominant requirement for entrance into college is a given level of knowledge, and that the output is a higher level of knowledge. The nature of the process is then obvious. It has to be "knowledge transfer".

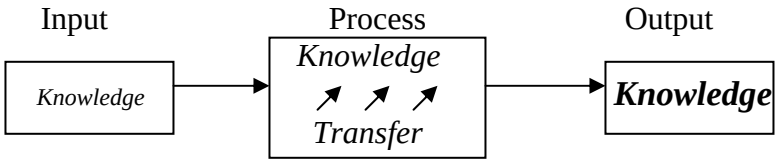


Figure 2: The academic manufacturing process

It is only a short further discussion that leads students to recognize that each one among them is the primary employee producing but one copy of the college's product, and that one copy is himself or

herself. That further discussion involves convincing students that they are not the customer in the sense that paying tuition entitles them to a diploma. Diplomas are vapid if the market place will not value theirs. Students, therefore, should view themselves as surrogate customers, and make sure that the customer they represent takes on a good product when hiring. Students ultimately want a job, and this discussion helps them see how better to obtain one.

With all the inspection stickers students have found in purchased items, they concede businesses inspect (or evaluate) their products. Since businesses rework or scrap faulty products found through inspection, the ideas of grading, repeating, and dismissal enter into the picture. The third figure introduces what quality literature calls the "hidden factory"[1] The hidden factory comprises rework and scrap.

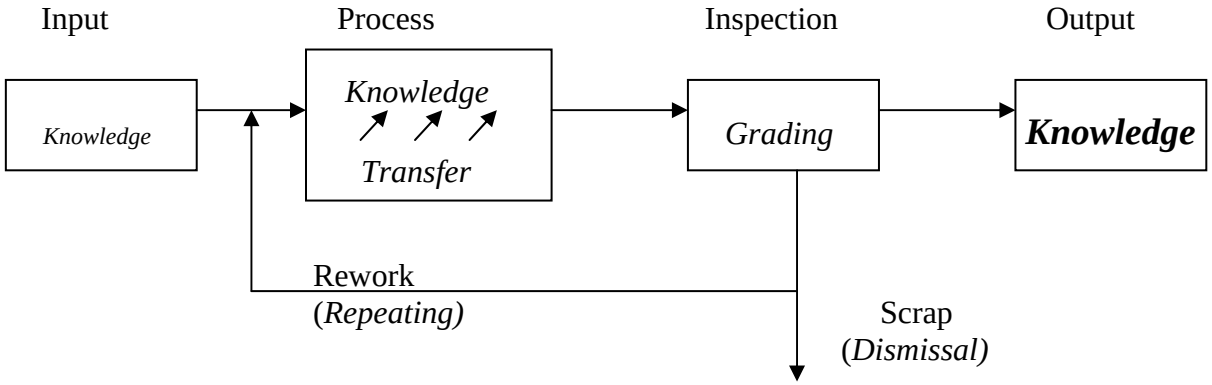


Figure 3. An expanded view of the academic manufacturing process

Through the above approach, students begin to understand how each owns a process that determines quality of the one copy he or she is making. Study habits and techniques comprise the individual's process. Grades become periodic assessments of a student's process.

Having students identified as employees, we next expose them to control charts. Even as manufacturing workers need to know how to interpret control charts[2] so that they can monitor the quality of products, students need to interpret grades in a similar manner. A typical control chart sequentially plots the metric of a process. A common control chart construction is such that, when a process is in control, the distribution of the metric values is a normal probability function. Management then sets upper and lower control limits. A common choice for those limits is three standard deviations from the expected value. Thus, if the measurement of a product falls within plus or minus three standard deviations of the mean, the worker may consider the process as under control. "Common cause" is the term applied to point-to-point variations in such a process. "Common cause"

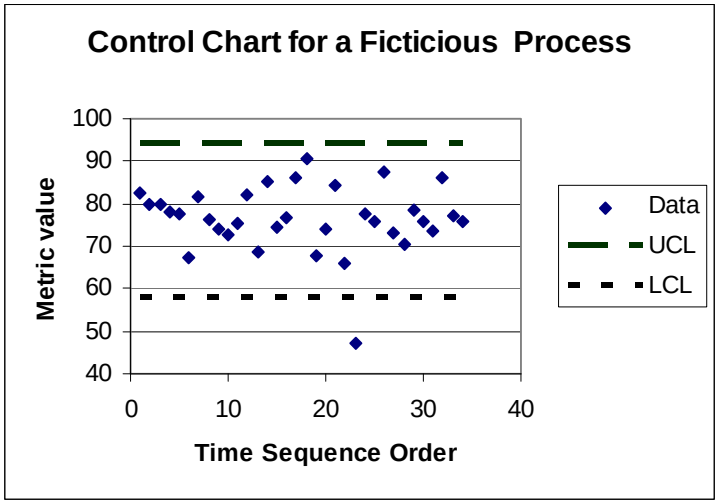


Figure 4: Control Chart with one point below the lower control limit (LCL)

requires no action on the part of the employee. The worker may leave things alone. If a measurement falls outside the limits, the worker should interpret the measurement as due to "special cause" A "special cause" warrants an investigation to find the specific cause and to take corrective action. See Figure 4 for an example control chart with one "special cause" point.

In considering the grade distribution on a test, what should we expect? We can deduce this: since we expect our students to come from a contiguous set of abilities and habits, we would expect a single distribution of grades. That distribution should be approximately normal. Bimodality does not match expectation.

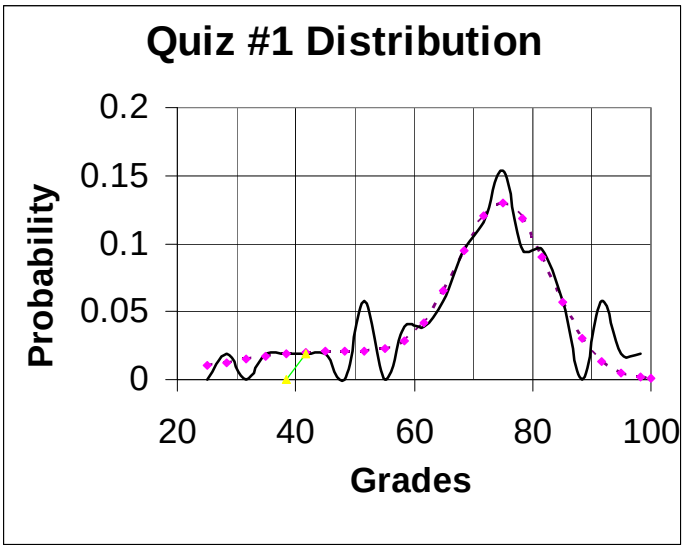


Figure 5: First Quiz grade distribution: upper mode mean = 76, upper control limit = 98.5, lower control limit = 53.5.

First year students enter college with little understanding of the process needed for success in their new environment. Some are much better off than others. An endemic feature of the first test that we administer to our first year engineers is a bimodal grade distribution. Figure 5 is the distribution of such a first test.

Back to the control chart idea – let us view our bimodal grade distribution as a control chart. We can place three sigma limits of the upper mode. If we consider the grades in the upper mode as "common cause", we gain insight. We may now consider the lower mode as "special cause". Thanks to students in our elective on Quality Control, we have a fleshed out list of possible special causes. I believe the most common special cause is an inadequate process, e.g., poor study habits. Here is the whole list:

- Short term
  - Break up with girl/boy
  - Flu
  - Forgot
  - Stressful issue
- Intermediate term
  - Loss of loved one
  - Faulty process (bad study habits)
  - Excessive work hours
  - Inadequate prerequisites
  - Inadequate process
  - Excessive extracurricular activities
  - Poor study environment
- Long term
  - Inferior secondary school education
  - Chaos in Dormitory
- Long term continued
  - Addiction
    - Pornography
    - Drugs
    - Video Games
    - Alcohol
  - Abuse
    - Physical
    - Sexual
    - Emotional
  - Psychological
    - Divorce of parents
    - Depression
  - Disability
    - ADD
    - Learning

List1. Possible causes for a student falling in the lower mode of the grade distribution

It is not that the grade distribution is a control chart. Technically, it is not. Experience with students vis-à-vis grades has, however, made the analogy valuable. The terms "special cause" and "common cause" fit the experience. I therefore inform students that this interpretation is no fairy tale. I can assure them that I have seen a student who suffered depression, another with ADD (even on medication), and yet another with girl problems all fall in the lower mode. (In the above listing, I underlined all the examples I have encountered.) I then implore students who find themselves in the lower mode to endeavor to determine the cause, and take corrective action.

I presented this control chart interpretation to a graduate of our engineering program. His reaction was, if that information had been presented to him in that way, he might have dealt with his problem sooner. In his sophomore year, his grades sagged. Something early in his life had caused the problem. He said it took about one year of counseling to work through it.

I believe that students knowledgeable about "special cause" should receive the distribution of grade results when suitable. I would deem any grade distribution comprised of a large enough number of tests to provide adequate statistics, perhaps greater than twenty data points, as potentially suitable. I also believe there is a second circumstance when the "special cause" interpretation applies: with rampant grade inflation, any F that a student receives in a course is likely to signal "special cause".

There is one warning to make when exposing students to the above view of the lower mode. It is this: some individuals in the upper mode may also suffer from the more serious long-term issues. Students in the upper mode need to hear of this reality. These individuals mask their problems through hard work and success. Even though successful, they should still be encouraged to address their particular issues.

The third idea from quality that has had impact is the notions that, "if you do not like your grades, change your process." This statement is a mutation of one of the questions and pronouncements of Lloyd S. Nelson as quoted by W. Edwards Deming.[3.] The question is, "If you can improve productivity, or sale, or quality, or anything else, by (e.g.) 5 percent next year without a rational plan for improvement, then why were you not doing it last year?" A student cannot just sit and do nothing and expect grades to improve. That student has to evaluate his or her process and change it. The rational plan may be as simple as not waiting until the last minute to study for a test. That is a process change, and implementation of the plan should result in improvement.

Once students have bought into the idea that each is the principle owner of a process, we need to place them in a position to manage it. Such management is their responsibility. Most students have never thought about education in this way. With their having this new insight, we can now teach attributes of academic processes as choices, e.g., time management, number of hours of study, use of professors, studying in groups, etc. We are no longer telling them "oughts" to do. If grades are acceptable to the individual, the student does not have to change anything. If not, we have given the student options for process improvement. The choice belongs to the student.

Does exposure to these three ideas work? Quantitative assessment seems aloof. I believe we are in the realm suggested by one of Lloyd Nelson's pronouncements: "The most important figures needed for management of any organization are unknown and unknowable."[3] Qualitative feedback, however, is positive. We have first year students submit a "portfolio" at the end of our Introduction to Engineering course. One of the sections on which they must comment is "Academic Success". Within those portfolios, either in the "Academic Success" section or the "Conclusion", is the often stated idea that "I realized I had to change my process". Because of the marked second-test improvement by students making this claim, I believe their claims. With the frequency of such claims, I believe inadequate process is the most common special cause. I have also twice had students not doing as well in my courses as they thought

they should inform me they had cut back or eliminated employment because they needed to "change their process". One anecdotal account from a junior two years ago was that when someone among their peers complained about a grade, other upper-class students shot back "Change your process."

Of some changes, we do not expect to hear. For example, we do not expect students to tell us that they sought counseling, or treatment for addictions. I do not to this day know the exact nature of the problem of the Messiah graduate of whom I made mention earlier. We do not need to know such details. We only need to encourage students to deal with their issues. To conclude this part of the discussion, I include the next paragraph from a student who decided not to pursue engineering. He wrote:

> "Introduction to Engineering has helped me out so much since I have started college. I am so grateful that I took this class even though I am switching my major. Some of the principles I have learned from this class will stick with me forever. Messiah College should use some of the same principles and teach them in the First Year Seminar Course. That way not only the engineering students can benefit but everybody can benefit."

At this point, I am not content. Were I president, provost, or dean, I would encourage those professors that work with first year students within my academic organization to experiment with new ideas about how to engage first year students into serious academic endeavor. The responsible individual should periodically convene this group of instructors for this purpose, to exchange notes and opinions on what works and what does not. I would then hope that they would adapt each other's good ideas within their own efforts. Better still would be if all were to agree to adopt or were required to adopt the same approach.

The previous paragraph implicitly suggests that, at the highest level, institutions genuinely attend to improving their own processes in dealing with the first year. There seems good motivation to do something along these lines. The motivation in mind is preservation of revenue. Many small colleges today are dependent on revenue from tuition to stay economically viable. What I suggest here could only help because it would promote success and fewer dismissals. That would preserve revenue. The motivation would increase in any environment that attempts to reverse grade inflation. Reducing overall average grade point average would only place more students in jeopardy of dismissal with its attendant loss of revenue.

Let us now assume that after convening professors working with first year students, the group decides to deploy a particular set of concepts as part of each professor's class. Here is a plan that I believe will maximize the benefit. I call it "Mass Mentoring"

1. Teach the concepts to all first year students within the given organization.
2. Since the selected concepts will have specific content and language, convene all faculty and advisors throughout the organization and teach them the concepts, emphasizing the language.
3. Ask all faculty and advisors to use the language and concepts when dealing with students, for example, in advising sessions. (In a business that expects to improve, personnel would be told to do so.)

It is not complicated. Perhaps in a few years an entire upper-class student body of a college will act as mentors when they shoot back, "Change your process."

David A. Gray, following retirement from AT&T Bell Telephone Laboratories, has been an assistant professor of engineering at Messiah College since 2000.

[1] Craig Gygi, Neil DeCarlo, and Bruce Williams, Six Sigma for Dummies, Wiley Publishing, Inc. (2005) p. 130

[2] *NIST/SEMATECH e-Handbook of Statistical Methods*, http://www.itl.nist.gov/div898/handbook/, chapter 6.

[3] W. Edwards Deming, Out of the Crisis, MIT Press, (2000) p. 20.