



CRITICAL THINKING IN PRODUCTION AND OPERATIONS MANAGEMENT COURSE - SOME EXPERIENCES AND TAKEAWAYS

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Abstract

Well-directed workshops usually help professors improve their teaching. This case study reports how student engagement and student learning was improved by incorporating critical thinking practices into an undergraduate Production and Operations Management class. With minor tweaks and adjustments to assignment activities and without adding any new material or content, it became possible to improve student engagement, receive very positive feedback and marginally improve student evaluation scores. We present herein what has worked in a Production and Operations Management class, as a result of our efforts to incorporate critical thinking into the pedagogy following the advice from a workshop on critical thinking.

Keywords: Critical Thinking, Elements of Thinking, Production and Operations Management, Fundamental and Powerful Concepts, Central Question

INTRODUCTION

It is well known to most academic administrators in Texas that the Texas Higher Education Coordinating Board (THECB, 2019) Rules, Chapter 4 Sub chapter B Rule 4.28 dealing with the Texas undergraduate core curriculum require, "Critical Thinking Skills: to include creative thinking, innovation, inquiry, and analysis, evaluation and synthesis of information," as a one of



six prescribed core objectives. So it's not surprising that all higher education institutions that offer the core curriculum courses invariably incorporate critical thinking into those core curriculum courses. At our university, as part of a Quality Enhancement Plan (QEP) under the SACS-COC reaccreditation process, a new initiative of Applied Critical Thinking as expressed through undergraduate research titled "ACT on IDEAs" was launched in the year 2015. This initiative sought to encourage faculty to expressly include critical thinking in all possible courses they teach in some measure. In order to prepare the faculty to actively participate in the new initiative, our university administration organized several information sessions, discussion sessions, workshops and other such support to promote the new QEP. Several faculty attended one such workshop over three days in the summer of 2015 conducted by Dr. Gerard M. Nosich. Nosich is a noted authority on critical thinking who has conducted over 250 workshops on critical thinking, and authored of several articles and books about critical thinking, such as "Learning to Think Things Through: A Guide to Critical Thinking Across the Curriculum," which is in its 4th edition (Nosich, 2012). We present herein the experiences and takeaways from the experimentations in incorporating critical thinking, following the advice at the workshop, in an undergraduate Production and Operations Management (POM) class.

What is Critical Thinking? Why should we care about Critical Thinking?

"Critical Thinking is the art of analyzing and evaluating thinking with a view to improving it" (Paul and Elder, 2009). Paul and Elder (2009) continue by asserting that all humans think and it is in our nature to think. Left to itself, much of our thinking is biased, distorted, partial, uninformed or downright prejudiced. Our life quality depends on the quality of our thinking. "Shoddy thinking is costly both in money and in quality of life. Excellence in thought, however, must be systematically cultivated" (Paul and Elder, 2009).

As a matter of fact, reflection is a very important tool. Unfortunately, current day students appear to have little or no time for reflection, with all the digital devices competing for their attention and time, and not to speak of other avocations the students surround themselves with. For example, pause for a moment and reflect on the statement, "our life quality depends on the quality of our thinking," from the preceding paragraph. The statement certainly merits deeper reflection. Most readers, upon deeper reflection, will invariably agree with the essence of that assertion. Continuing to reflect on the same lines, it is not hard to visualize what kind of efforts must be made to cultivate critical thinking and how the resultant critical thinking would enhance the quality of our life. The clue is in the statement describing, "How the human thinking, left to itself, would look like." Therefore, if we know that our thinking, left to itself, would suffer from such identifiable deficiencies described in the preceding paragraph, it is but logical that our

efforts should be directed towards overcoming every one of those deficiencies. In other words, a systematically cultivated critical thinking would overcome the deficiencies of biases, distortions, being partial, uninformed and/or downright prejudiced. As Paul and Elder (2009) summarize it, “critical thinking is self-directed, self-disciplined, self-monitored, and self-corrective thinking.”

Elements of Thought

In order to appreciate the process of cultivating critical thinking, one must first begin by understanding the elements of thoughts and how thoughts are developed and formed. As noted earlier, deep reflection can lead to better understanding of the ideas at hand. Extending that logic, one can reasonably conclude that reflecting on the elements of thought and their contribution towards developing and forming human thoughts can lead to achieving critical thinking capabilities. Figure 1 below depicts the elements of thought (Paul and Elder, 2009).

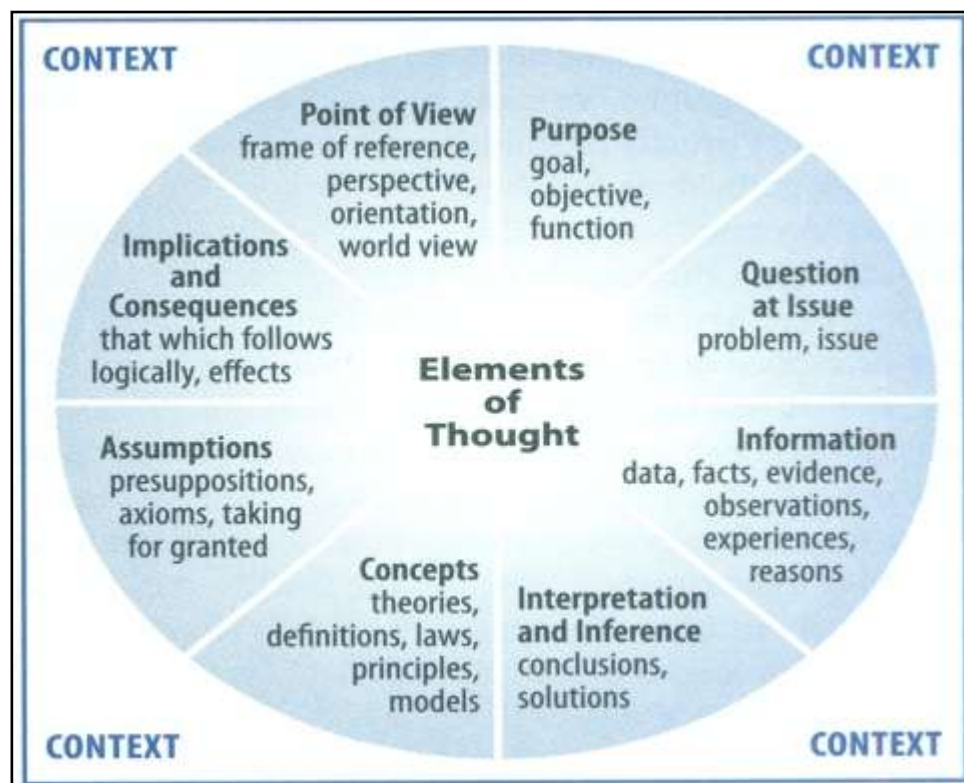


Figure 1: Elements of Thought (Paul and Elder, 2009).

Universal Intellectual Standards:

Quoting extensively from Paul and Elder (2009), Nosich presented the process of applying universal intellectual standards to the elements of thought as depicted above, to attain the

intellectual traits that round up the process of becoming a critical thinker. The universal intellectual standards are Clarity, Accuracy, Precision, Relevance, Depth, Breadth, Logic and Fairness. It is essential that these standards must be applied to the elements of thoughts in a systematic manner to ensure reaching a higher order of thinking. The process of applying the universal intellectual standards to the elements of thoughts involves asking a series of questions, pertaining to each of the standards, one by one to ensure that the thinking is not flawed and does not suffer from other deficiencies preventing it from reaching the critical thinking level. Consider for example the following set of questions under each standard as presented by Paul and Elder (2009).

Clarity:

- Could you elaborate it further?
- Could you give me an example?
- Could you illustrate what you mean?

Accuracy:

- How could we check on that?
- How could we find out if it's true?
- How could we verify or test that?

By seeking answers to these and other questions relating to the universal intellectual standards as detailed by Paul and Elder (2009), we can achieve a higher order of thinking.

At the 2015 summer workshop referred to above, Nosich observed that these standards are equally applicable in writing research articles and other intellectual contributions. Further, he advised that these standards can also be used to review academic articles for teaching purposes or publication purposes. We certainly can use these standards for creating rubrics for grading class project reports. By creating the rubric with these or similar questions and presenting the rubric to the students at the start of the semester, an instructor can set the tone for the expectations of a class project report.

What does Critical Thinking involve? And what it does not?

Following the discussion about the universal intellectual standards and the questions to ask in order to implement the standards, it is not hard to visualize that “critical thinking involves asking the questions to be asked.” Further as Nosich asserts, critical thinking involves thinking through the questions to answer them and believing that your answers are correct for the problem at hand (Nosich, 2013). The thinker should be able to take his thoughts seriously and be able to

internalize these thoughts. As for what critical thinking is not, “hearing doesn’t amount to processing as such, it is not critical thinking.” Similarly, the act of “taking notes is not processing and as such, it is not critical thinking” (Nosich, 2013).

Suggestions to promote Critical Thinking

In the light of foregoing discussion and inferences, one very important suggestion to promote critical thinking is, ‘make students to think a lot.’ Therefore, classroom activities, as well as other class-related assignments should entail extensive thinking on the part of the students to promote the development of critical thinking skills. As such, it becomes obvious that the type of work that can be done by mere memorization or referencing of the textbook does not promote critical thinking. Further, when students internalize the learning in terms of how the knowledge from a discipline would benefit them now or in the future, they tend to stay engaged and learn better. In order to facilitate such internalization of learning, assignments should evoke questions such as, how does this concept /knowledge relate to my life or real world? What is the purpose of this idea or concept? What will happen if the concept is implemented correctly or not implemented correctly? Ideally, the assignments should require the students to “go around the circle” of elements of thought so that they analyze the issues at hand and understand the underlying concepts at a deeper level.

In summary, a teacher could use the elements of thought to promote critical thinking in the classroom by:

- Encouraging students to ask good questions and to read analytically
- Engaging student in group discussions
- Creating suitable assessment and feedback
- Encouraging content mastery – through discipline-based content, following the elements of thought while applying the universal intellectual standards
- Requiring writing activities in a more disciplined way – following intellectual standards

The S.E.E.I technique could be used as writing technique that promotes critical thinking and deeper learning. (Nosich, 20015b). S.E.E.I. stands for State, Elaborate, Exemplify, and Illustrate.

- State – the concept or the idea
- Elaborate – by beginning with “in other words....”
- Exemplify – provide an example
- Illustrate -- give a set of metaphoric, typically, visual expressions

As Nosich (2015b) asserts, S.E.E.I. technique finds use in many different contexts. In answering questions, writing academic papers, and research papers or otherwise, in a meaningful and substantive manner.

Learning to Think Things Through:

Skills of learning to think things through can apply to practically all disciplines.

“Typically, students have two main questions: If I take a course in a discipline, how can I think critically within that discipline? How do I learn to think critically while also amassing the large amount of information --- often misleadingly called the content --- I may need to learn in the course?” (Nosich, 2012).

The answer to these two questions are directly related to the Fundamental and Powerful Concepts (F & PC) of a field within a discipline or course of study in a discipline. Typically, F & PC are those that can explain or think out a huge body of questions, problems, information, and situations (Nosich, 2012). The recommended process of identifying the F & PC is to review the entire course as a whole and attempt to come up with just one at first, and then to come up with one or two more that stem from the first one. In fact, the F & PC of some disciplines may be able to help understand and resolve the life issues and problems seemingly unrelated to the discipline in question. Once students recognize and understand the Fundamental and Powerful Concepts of a discipline, learning the later concepts and theories of the discipline becomes easier. To practice the process of learning to think things through, one must begin with the underlying logic of a field or discipline, familiarize oneself with the vocabulary of the field/discipline, and then begin to think using the vocabulary of the discipline. As is well known, certain expressions have a very specific meaning when used in the context of a specific discipline. As such, it is very important that the students first develop sufficient familiarity with the terminology of a given field or discipline. The instructor can restructure the pedagogy in leading the students in the right direction to put a deeper understanding of the F & PC at the center of the student learning. Assignments, group work, tests, reading, writing, projects, presentations, homework, etc. all can be restructured focusing on F & PC. As per Nosich (2012), “if you let it, F & PC can change your whole idea of teaching a course,” and possibly, improve critical thinking skills of the students in the process.

The Fundamental and Powerful Concepts technique is well complemented by the equally important “central question” technique. The central question technique is a great way to keep students on track, to see the logic of the field, and learn to think things through. The instructor should identify and present to the students, the central question of the course as a whole. While framing this central question, one needs to reflect on “how do the ideas discussed

in various chapters fit together to help me learn to think critically in the field?” The central question may be simple – simple in terms of being uncomplicated. However, care must be exercised to avoid using the Fundamental and Powerful concepts to frame the central question of the course. Also, it is quite possible that there may be not just one but two more central questions, and that is alright; but the fewer the better (Nosich, 2012). This central question can guide the students just like a compass to stay on course to understand how the various ideas, concepts, and theories discussed in the course are tied together towards answering and addressing the central question(s). Consider for example the central questions of a couple of domains:

- Educational psychology: how does a student learn? A related second question would be, how can I (Instructor) help students learn?
- Economics: how is society shaped by the decisions people make on the basis of expected costs and benefits?

The idea is to think critically about any and every aspect of that course to see how it all fits together to help the learners to answer the central question. For example: a student might wonder how the issues discussed in chapter 1 fit together with the theories discussed in a later chapter to help the learner to think critically in the field. It is also essential to understand how the central question forms the unifying structure around which all other elements and concepts in the course are organized (Nosich, 2012).

Applying Critical Thinking Concepts to the Undergraduate POM Course

POM 3310- Production and Operations Management is a Common Body of Knowledge (C-BOK) course for a BBA diploma in most four year universities offering BBA. Accordingly, all business students are required to take this course regardless of their major or concentration within the BBA diploma. In that respect, POM 3310 is a good course to implement critical thinking concepts.

We begin with identifying fundamental and powerful concepts and central question(s) for the POM course. At our university, the course catalog describes POM 3310 as follows: “Introduces the student to planning, organizing, and controlling production and service systems. The impact of new product and process technologies will also be covered. Written and/or oral presentations are required. Prerequisite: DS 2310.” The DS in the DS 2310 stands for Decision Sciences and DS 2310 is a Business Statistics course which is a Field of Study (FOS) course required of all business majors. Quite a few of the Statistics concepts and tools and techniques form the essential foundational knowledge to properly appreciate and learn the theories and concepts of POM3310.

If we analyze business organizations carefully, it is not difficult to come to the inevitable conclusion that “all businesses are involved in, essentially, the same common activity of transforming inputs into outputs.” Specifically, the outputs that can satisfy wants as discussed in Principles of Economics course. Upon deeper reflection, a student is bound to reach the realization that no outputs can be produced without using inputs. Further guidance by the instructor can lead the student to note that the principle of ‘converting inputs into outputs’ is but the principle of conservation of mass (or matter) discussed in high school physics class viz., mass cannot be created or destroyed but it can change forms.

In the POM course, it is impressed upon the learners that the transformation process of inputs into desired outputs must be both efficient and effective. Although efficiency and effectiveness are typically coexistent, there is a definite distinction in their focus and emphasis as discussed in the context of Production and Operations Management. This distinction is presented as “doing things right vs. doing the right things.” While efficiency is doing things right (lowest possible cost), effectiveness is doing right things (creating most value to customers) (Jacobs and Chase, 2020).

Over the past three decades, the main purpose or the focus of a business has shifted from being just profit to people, planet, and profit. In other words, the focus is shifted to social, environmental and economic a.k.a. Triple Bottom-line (TBL) (Jacobs and Chase, 2020).

The concepts detailed above qualify as the Fundamental and Powerful Concepts (F & PC) of Production and Operations Management and one can summarize the same as follows:

- Transforming inputs into outputs
- Transformation process is efficient and effective
- Business organization is triple bottom-line focused.

Additionally, for those who are trained in Systems Thinking, it is not difficult to see a business organization as a system and the functional areas of a business as being parts of a system whose synchronous functioning is essential for the smooth operations of the entire organization. In other words, “Systems Thinking” and viewing business organizations as systems could also be a Fundamental and Powerful concept of Production and Operations Management course.

Central Question for the Production and Operations Management Course

After careful analysis and taking utmost care to not repeat the Fundamental and Powerful concepts, the following central question is developed. “How do business organizations determine what goods and services to produce and how do businesses chose specific tools, techniques and processes to produce those goods? “ Practically, this central question helps to

present the various chapters in a POM class such as, product design, forecasting, capacity planning, manufacturing processes, service processes, waiting line models, quality management, and inventory management etc., all of them contributing the address the central question. The student can quickly see the connection between the chapter concepts and the central question of the course.

Some minor tweaks

The Fundamental and Powerful Concepts (F &PC) and the Central Question are introduced early on the semester with emphasis on observing how all concepts and discussions in various chapters combine to address the central question while all long being influenced by the F & PCs. In a face-to-face class, the instructor may find it helpful to refer back to F & PC at the start of each chapter and to generally relate all discussions to explain how they combine to address the central question of the course. Once students get used to thinking in terms of F & PC and start relating the discussions from various chapters from the point of view of the central questions, their overall comprehension of the course material improves. Students start to enjoy the course more, which will be evidenced in the feedback they provide in the student evaluations.

Frequent Low Stakes Writing Assignments

The recommendations provided for promoting critical thinking included, “when students internalize the learning in terms of how the knowledge from a discipline would benefit them now or in future, they tend to stay engaged and learn better.” In pursuance of this recommendation, we have effected a few minor tweaks to the weekly discussion forum requirements in the POM 3310 class in the nature of introducing a rubric for the grading weekly discussion forum. The rubric is designed in a manner to ensure that students do reflect on the chapter material before they post their learning notes. Further, by visualizing how the new knowledge may be helpful to them they will be prone to internalize the learning that much more than otherwise. Consider the excerpts from the POM 3310- fall 2019 syllabus.

“You are required to participate in the discussion forum each week to ensure a better learning experience. Participation in the discussion forum counts towards the class participation points. Each of you after reading the chapter and submitting the assignment is required to post a brief note of 3 or 4 sentences (in any case not exceeding 60 words) on the related discussion forum to report, “What new knowledge did you gain from the chapter that you didn’t know before reading the chapter, briefly describe it in your own words and explain how may this new knowledge be useful to you in your studies/work/life or otherwise”. You are also required to

review others posts and reply to at least two other students posts to receive full credit for each week's discussion forum grade. Each of your replies to other students' posts should be polite, relevant to the topic under discussion and at least three sentences long.

This review and reply process helps you to recognize multiple perspectives of the material covered in the chapter from other students' points of view. Your post and replies will be graded using a rubric showing below."

Table 1: Discussion Forum Rubric

Level/ Grade	Lacking focus	Unacceptable	Needs improvement	Acceptable effort	Good effort	Excellent
Weigh Details	0%	50%	70%	80%	90%	100%
Topic for post 50%	Irrelevant topic (not discussed in the chapter) OR incorrect identification of concept or topic	Long post lacking focus and expected components	Correct topic- incorrect description or incorrect explanations of how it may be useful in studies/work / life or otherwise	Correctly identifies the topic- OMITS to briefly describes it- OR OMITS to explain how it may be useful in studies/work/life or otherwise	Correctly identifies the topic- briefly describes it- OMITS to explain how it may be useful in studies/ work/life or otherwise	Correctly identifies the topic- briefly describes it- thoughtfully explains how it may be useful in studies/ work/life or otherwise
Replies 30%	Totally missed to reply	Cursory attempt at replies- incomplete sentences	Cursory attempt at replies with the only or both replies less than three sentences.	Replies to only one post but fully complying with requirements	Replies to two posts but only one is properly framed to meet requirements; the other is a	Appropriate replies to at least two other posts. Each reply is pertinent and at least three sentences
Grammar/ mechanics etc. 20%		Incomplete sentences / incoherent post	Two or more misspellings /errors leading to incorrect meaning	Two or more misspellings but no major / other omissions or errors	No misspellings but minor grammatical / requirement	No misspellings or other grammatical errors

The discussion forum requirements provide the student the opportunity to express their thoughts in a relatively low stakes assignment. Each chapter discussion participation counts for 4 points for a total of 48 points for twelve chapters. This total of 48 in the overall course total of 500 points is just a little under 10% of the course grade. Given that the instructor provides feedback for each week's post using the rubric scoring as well as written comments, suggesting possible improvements and complimenting well-presented thoughts, students gradually learn to express their understanding of the new concepts better over the course of a semester. This activity also helps to gauge the students' familiarity with the terminology of the course and nudges them into using the right expressions when the post appears to use rather general expressions instead of the context specific technical terms.

The requirement of discussing how this new knowledge be useful to them in their studies/work/life or otherwise makes students reflect on the possible uses of new knowledge, say about efficiency, effectiveness, forecasting, order winner features, sustainability, triple bottom-line, waiting line models, TQM, Six Sigma philosophy etc. to see where they can apply them. In the process, they internalize their learning, start to understand these concepts at a deeper level. This may also result in longer retention of the knowledge.

Student evaluation scores have been improving with each passing semester. Student feedback comments are also gradually becoming more positive and appreciative of the learning from the class. Here are a few excerpts from fall 2019 student evaluations:

Student responses to the item, "What I liked most about this course is..."

- How P.O.M relates to overall business.
- The instructor engaged and offered constructive feedback with discussions throughout the semester which helped me gain a better understanding of how topics discussed in class affect my life
- Class is very well organized and Professor always gave us feedback about our assignments. His PowerPoints are very informative and help a great deal with his notes on the slides.

It is always very satisfying for professors to receive positive feedback about the subtle changes and improvements incorporated in the class delivery. The weekly discussion forum participation and the interaction among the students and the instructor feedback for the posts have specifically been complimented as very engaging and useful learning experiences in the student evaluations. Overall, the minor tweaks made to incorporate critical thinking in the class appear to pay off very well. While it takes time and effort to create the initial set of lecture notes, assignments, material etc., all future and subsequent improvements/enhancements and modifications are very easily accomplished. Reviewing the student evaluations and gradually addressing the students' common concerns in those comments over a couple of semester will

help the course delivery to reach a robust standard that can yield dividends for many semesters to follow.

CONCLUSIONS AND TAKEAWAYS

Systematic efforts to incorporate critical thinking in POM class can help improve students' learning and engagement. While there may be many different approaches to include critical thinking in courses, the approaches discussed in this case study appear to have worked well with POM 3310 course. Taking cues from this class, weekly discussions and other assignments involving critical thinking, and activities using SEEI technique have been implemented in a graduate Management seminar course as well, with much better success than expected. In a face-to face class, it may be useful to include more group discussions, particularly, requiring the students discuss the ideas by going around the wheel of elements of thought. Certainly, critical thinking has the potential to improve student engagement and improve student learning, not to mention the resulting improvement in student evaluation scores.

WAY FORWARD

As may be noted from this case study, there exist many more opportunities to incorporate critical thinking in several different courses. By carefully redesigning the assignments and consciously including the activities that promote critical thinking, it is possible to ensure that all students, regardless of their major /discipline, are bestowed with sound critical thinking skills. As was noted earlier, 'our life quality depends upon the quality of our thinking'; so it is but logical that we all should endeavor to ensure that all of us in the society are able to use critical thinking so that the overall quality of life on earth can be improved many folds.

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