TQM Applied to an Educational Organization

Dr. Mysore Narayanan, Miami University

DR. MYSORE NARAYANAN obtained his Ph.D. from the University of Liverpool, England in the area of Electrical and Electronic Engineering. He joined Miami University in 1980 and teaches a wide variety of electrical, electronic and mechanical engineering courses. He has been invited to contribute articles to several encyclopedias and has published and presented dozens of papers at local, regional, national and international conferences. He has also designed, developed, organized and chaired several conferences for Miami University and conference sessions for a variety of organizations. He is a senior member of IEEE and is a member of ASME, SIAM, ASEE and AGU. He is actively involved in CELT activities and regularly participates and presents at the Lilly Conference. He has been the recipient of several Faculty Learning Community awards. He is also very active in assessment activities and has presented more than thirty five papers at various Assessment Institutes. His posters in the areas of Assessment, Bloom’s Taxonomy and Socratic Inquisition have received widespread acclaim from several scholars in the area of Cognitive Science and Educational Methodologies. He has received the Assessment of Critical Thinking Award twice and is currently working towards incorporating writing assignments that enhance students’ critical thinking capabilities.
Abstract

In this study, the author discusses the beneficial aspects of TQM and PBL and provides an insight as to how these two can be intelligently incorporated in an educational institution. It is a well-known fact that TQM requires considerable time for its effective implementation. Some experts indicate that this is about five years. Researchers Kevin B. Hendricks of Richard Ivey School of Business, the University of Western Ontario and Vinod R. Singhal of Georgia Institute of Technology have studied three thousand firms and determined that the firms that used TQM effectively did fare significantly better in profitability.

However, it must be emphasized that TQM must permeate throughout the entire organization in order to be really effective. When TQM and PBL are applied to an educational organization, one must recognize the fact that it will take several years for it to permeate throughout the entire university administrative structure. In reality, it may take much more time for its benefits to be reaped by students and the learning community.

Furthermore, all educators agree that the 21st century workplace does not need employees who have just mastered a particular body of information. In reality, one prefers to have liberally educated engineers who have mastered interpersonal as well as intrapersonal skills. The new millennium also needs an enlightened workforce that possesses written and oral communication skills in addition to acquiring in-depth knowledge in their chosen discipline.

Leading scholars in the area of Cognitive Science and Educational Methodologies have concluded that it is essential that students need to be taught in a creative learning environment. Educators who utilize the Discovery Approach help students acquire much needed real-world problem-solving skills. In this paper the author outlines how interactive projects can help the instructor in promoting a problem-based learning environment. Furthermore, he also provides initial results of his assessment data.

Introduction

Educators should not allow the students to wonder whether they have been learning anything that would actually serve them in the workplace, upon graduation (Barr & Tagg, 1995). It is also important to recognize that state legislatures have introduced demands for outcome assessment (Magill & Herden, 1995). Problem-based learning (PBL) environment should promote and document accomplishments at the upper levels of Bloom’s Taxonomy Triangle (Boud & Feletti, 1991; Engel, 1991).

Scholars have identified four features that clearly separate a problem-based curriculum from a traditional topic-based curriculum (Nickerson, et. al. 1985). The Impact of College on Students has been discussed by Ernest T. Pascarella and Patrick T. Terenzini in their famous
publication and provides an insight as to how instructors can successfully motivate the 21st century student body (Pascarella & Terenzini, 1995).

The author has talked about the importance of TQM & PBL in several of his ASEE publications and presentations (Narayanan, 2007, 2009, 2012 & 2019). Part of it has been reproduced here, as a part of literature survey for sake of clarity and completeness.

Some have also criticized TQM for not generating enough benefits as demonstrated through increased stock price performance. This is not directly relevant in a university or educational establishment. Therefore, the author re-examines university teaching strategies to support teaching innovations and classroom excellence. He has applied some of the principles of Total Quality Management to classroom teaching with a view to facilitate better classroom management and increased student participation. For this purpose he has relied on Problem Based Learning (PBL) techniques. In this paper, the author reports on his findings while applying these principles to teach a senior level engineering course.

Paul Nolting’s Research

Another scholar, Dr. Paul Nolting, Title III Coordinator at Manatee Community College Bradenton, Florida has compared Student Learning Styles and provides guidelines for making the 21st century classroom more dynamic and vibrant.

In his publication, Dr. Nolting concludes:

*It would be a mistake to think that the only problem under prepared students has is their knowledge base (McCabe, 2003).*

*The idea of learner-centered education is that students must make a connection between the content and their perception of learning (Perin, 2001).*

*To help students better understand their learning, some institutions have attempted to help students define their own learning style by giving them different learning styles inventories (Nolting, 2000 & 2007)*

Dr. Paul Nolting also comments that:

“By identifying student learning styles and dissemination styles, then students have a better chance to identify with a delivery method that most closely aligns with their ability to learn (McCabe, 2003).

Also faculty would have a better understanding on how their students learn in order to modify some of their delivery methods.”
The studies briefly reported in a paper entitled “Teaching thinking–A focus for science teaching?” the authors reveal the enormous potential hidden in the 21st century student body. It is possible to improve the thinking skills of students utilizing PBL techniques and facilitating Four Features of Learning promoted by various scholars (Nickerson, Perkins & Smith. 1985).

Four Features of Learning

Psychologists Raymond S. Nickerson, David N. Perkins and Edward E. Smith discuss what is popularly known as Four Features of Learning in their famous book entitled The Teaching of Thinking. The author has successfully utilized several ideas of these authors in of his ASEE publications and presentations (Narayanan, 2019). Here are the four features suggested by Nickerson.

1. Learning must be Cumulative:

The subject matter is not learned by the student in great depth at one long stretch. On the contrary, the topics are introduced gradually and repeatedly. Furthermore, the level of complexity of subject matter should increase with the progression of time. This is very much true in the area of Advanced Engineering Mathematics. For example, students understand the principles of integration initially. Later on, they proceed to learn about Contour Integral, Surface Integral and Triple Integrals.

2. Learning must be Integrated:

The subject matter is must not introduced with a stand-alone approach. Topics are always discussed as the correlate to a real world problem. In other words, the students clearly understand the need for rigorous mathematical analysis that is necessary for emphasizing engineering design. For example, knowledge of Hyperbolic Functions is essential if the students are designing a structure such as St. Louis Arch.

3. Learning must be Progressive:

The student's learning keeps changing continuously. Learners begin acquiring specific skills and knowledge of subject matter. As time progresses, this knowledge base is expanded and integrated with what has already been learnt. For example, students initially learn about the importance of Natural Frequency Calculations. These are the needed mathematical techniques that they subsequently utilize in the Mechanical Vibrations Course.
4. Learning must be Consistent:

The learning environment created should ensure repeatability. Every learner should accomplish identical goals and educational outcomes. Individual learning styles should have no impact on the knowledge acquired. This is easily accomplished by documenting student-generated work such as homework assignments, research reports, tests and quizzes, examinations, project binders, etc.

Implementation

To promote TQM & PBL, at Miami University, The author utilizes a variety of additional instructional tools in addition to routinely used methodologies like traditional lectures and laboratory exercises. The author heavily promotes the implementation of 21st century modern technology. This includes, but not limited to: World Wide Web, WebEx, I.V.D.L. (Interactive Video Distance Learning) etc.

The main objective is to communicate with students who may prefer to have different learning styles (Kolb, 1985). The author has tried to address all the four areas suggested by Nickerson in this research activity. Regardless, the author’s goal has always been to deliver information to students in the best possible manner that suits the receiver’s optimum learning style.

Data Collection Procedure

Data was collected from 18 students, over a period of one semester.

Course: Dynamics. University Junior Level

Topic Discussed and Specific Subject Matter: Dynamics of Sports.

The students were later examined on the above mentioned topic in a one–hour exam and data was collected.

Procedure followed by the author is symbolically represented in Appendix A.

Grading was administered using Washington State University’s Rubric. This is shown Appendix B.

Grading was holistic and qualitative. No quantitative grade points or percentages were recorded.
Grading was recorded based on student’s perception, grasp and depth of understanding of the topic.

Four “Characteristics” suggested by Nickerson were assessed and recorded using a 5 point Likert Scale. Details are shown in Appendix C.

Data Display

- Instructor graded the exam and documented his observations using EXCEL Spreadsheet format.
- EXCEL Spreadsheet data summary and a sample of grading scheme is shown in Appendix C.
- A Bar chart was generated based on EXCEL Spreadsheet data summary and this is shown in Appendix D.

Data Analysis

Bar chart displayed in Appendix D indicates that none of the 4 characteristics assessed recorded a Likert Scale mode values of 5.

Regardless, two of the characteristics assessed recorded a Likert Scale Mode value of 4. This is quite encouraging.

Based on the bar chart generated one can see that the two “characteristics”

Characteristic # 1 (Learning must be Cumulative)
Characteristic # 3 (Learning must be Progressive)

both show respectable mode values of 4.
The author is indeed surprised to see this because in an engineering discipline learning is always progressive as well as cumulative. Students need to have a fairly sound knowledge of Physics and Mathematics before they take a course in Dynamics. However, the author is trying to explore possibilities and is trying to accomplish a mode value of 5 for both of these characteristics.

Again, the bar chart displayed in Appendix D indicates that two of the characteristics assessed recorded a Likert Scale Mode value of 3. This indicates that there is plenty of room for improvement.

The author is however, happy that none of the characteristics assessed recorded a mode value of 2 or below 2.

Based on the bar chart generated one can see that the two “characteristics”

Characteristic # 2 (Learning must be Integrated)

Characteristic # 4 (Learning must be Consistent)

both show respectable mode values of 3.

Again, the author was expecting a mode value of 4 or higher in these two categories. Engineering classes are mostly integrated and one course normally builds on another.

Regardless, the author is exploring ways to communicate better with the students, so that he can accomplish a mode value of at least 4 initially.

Of course, the ultimate goal is to attain a mode value of 5 for all the four characteristics.

Conclusions

Based on the “Data Analysis” the author concludes there is a need for instructors to focus more on creating PBL based classroom for the 21st Century. This will be a dynamic environment wherein the instructor and the learner collaborate towards achieving a common goal. The common goal being “Learner-Centered Education.” The great success of Barr and Tagg’s research in the area of “learning paradigm” points towards the kind of change needed in university education (Barr & Tagg, 2012).
References


Appendix A: Procedure followed by the Author

1. Continuous Improvement
2. Select W.S.U. Rubric
3. Analyze Data Collected
4. Draw Conclusions
5. TQM & PBL Assignment
### APPENDIX B : Critical Thinking Rubrics (Courtesy of W.S.U., Pullman, WA.)

### LIKERT SCALE ANALYSIS. 5: Strongly Agree  1: Strongly Disagree

<table>
<thead>
<tr>
<th>Score</th>
<th>Positive Comments</th>
<th>Negative Comments</th>
</tr>
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</table>
| 5     | Has demonstrated excellence.  
       | Has analyzed important data precisely.  
       | Very good performance. | Has addressed problems effectively.  
       | Has answered key questions correctly.  
       | Evidence of critical thinking ability.  
       | Has evaluated material with proper insight.  |
| 3     | Has demonstrated competency.  
       | Data analysis can be improved.  
       | Adequate documentation.  
       | More effort to address key questions.  
       | Critical thinking ability exists.  
       | Need to address problems effectively.  |
|       | Acceptable performance.  
       | Expand on evaluating material.  
       | | Improve deductive reasoning skills.  
       | | Improve inductive reasoning skills.  
       | | Problem solving skills need honing.  |
|       | | Must discuss consequences of decisions.  
       | | Has been vague with inference.  |
| 1     | Poor, unacceptable performance.  
       | Absence of analytical skills.  
       | Lacks critical thinking ability.  
       | Answers questions incorrectly.  
       | Addresses problems superficially.  
       | Lacks documentation.  
       | Inability to evaluate material.  
       | Shows no deductive reasoning power.  
       | Inductive reasoning power non existent.  
       | Poor problem solving skills  
       | Unaware of consequences of decisions.  
       | Unable to draw conclusions.  |

Source: Critical Thinking Rubric, [Washington State University](http://wsuctproject.wsu.edu/ctr.htm), P.O. Box 644530, Pullman, WA 99164 - 4530 USA. (2005)  
The author has utilized this rubric in several of his ASEE publications (2000 – 2019).
## Appendix C: Spreadsheet Analysis of Four Characteristics

### TQM & PBL: Learning Must be

**TOTAL NUMBER OF STUDENTS = 18**

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<td>3</td>
<td>4</td>
<td>...</td>
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</table>

**THE CRITICAL THINKING RUBRIC**

RUBRIC COURTESY OF W. S. U.
WASHINGTON STATE UNIVERSITY
PULLMAN, WA. 99164.

**LIKERT SCALE**

**WEIGHT DISTRIBUTION**
1 : Strongly Disagree
5 : Strongly Agree

<table>
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<tr>
<th></th>
<th>Cumulative</th>
<th>4</th>
<th>4</th>
<th>5</th>
<th>5</th>
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<tbody>
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<td>3</td>
<td>3</td>
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<td></td>
<td>3</td>
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<tr>
<td>3</td>
<td>Progressive</td>
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<td>5</td>
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<td></td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>Consistent</td>
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<td>5</td>
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<td>3</td>
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Data Collected by: Mysore Narayanan.
Appendix D: Bar Chart based on Spreadsheet Analysis

TQM & PBL: Learning Must be:

Consistent
Progressive
Integrated
Cumulative

5 - Point LIKERT SCALE