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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 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 35 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.

Assessment of TQM in the 21ST Century

Abstract

Total Quality Management or T.Q.M. is an idea that is based on existing philosophies and techniques. The movement is a reaction of United States companies in response to declining productivity and sales in the worldwide trade market due to inferior quality. Total quality management is a series of procedures and philosophies taken to create an environment, or culture, of success. This paper explores the possibilities of incorporating these principles *judiciously* in to the classroom activities. Although the idea of total quality management is new, the basic principles have been used for centuries. However, the total quality management movement can be attributed to starting with a few *pioneers.* These pioneers are known in the business world as W. Edwards Demming, Joseph M. Juran, and Philip Crosby. Each scholar has his own criteria for quality management, but there are many similarities between them. Total quality management is an approach in which all the company's people are involved in constantly improving the quality of products, services, and business processes. Total quality management is a tool that can help a company achieve total customer satisfaction through better quality products. In this presentation, the author discusses how to assess the benefits of TQM in a classroom environment. He also provides an example and discusses the results and the implications.

Introduction

The author has previously presented some of these ideas at the 2003 ASEE National Conference in Nashville, Tennessee. In that presentation, the author re-examined university teaching strategies to support teaching innovations and classroom excellence. He had applied some of the principles of Total Quality Management to classroom teaching with a view to facilitate better classroom management and increased student participation. The author reported on his findings while applying a set of twenty principles while teaching a senior level engineering course. He re-visited the learning pyramid and examined its usefulness while discussing an engineering subject matter. He used the principles of TQM to investigating ways to promote good teaching and raised a number of issues about supporting innovative and creative teaching methods in an institution of higher learning (Jablonski, 1994). Based on his classroom experiences, he concluded that a culture of creative changes and significant teaching improvements could be accomplished by applying some of the principles of TQM to the classroom experience across a university. TQM is an organizational strategy of commitment to improving satisfaction by developing techniques to carefully manage output quality. For TQM to work, it requires everyone in the organization, from the lowest-level employee to the CEO, to be committed fully to making whatever innovations are necessary to improve it. For years Japan had taken advantage of TQM. Japan was the first country to award a

national quality prize, the Deming prize, named after the American statistician who taught the importance of quality to postwar Japan (Deming, 1982 & 1986).

Ernest L. Boyer, in his 1990 book, *Scholarship Reconsidered: Priorities of the Professorate* suggests that there has been an attempt to redefine the University Teacher-Scholar's role in the academic environment. In his 1990 book, published by the Carnegie Foundation for the Advancement of Teaching, Boyer cites some ground breaking studies and offers a new paradigm that identifies the need to recognize the growing conversation about teaching, scholarship and research in the Universities. Boyer's research on redefining scholarly work to include teaching has had a profound impact on the way teaching is viewed at Universities and Colleges (Boyer, 1990). Regardless, the relationship between scholarship of teaching and scholarship of discovery research is neither simple nor can easily be documented. Several studies have indicated that outstanding research faculty need not necessarily be good classroom teachers. Further, teachers who excel in the classroom need not necessarily be good at research. However, it is clear that it is possible to improve teaching, through better effort. Everyone agrees that both activities are important in Universities. Traditionally, outstanding research has always been rewarded better than outstanding teaching, because of the perception that research is a high-stakes activity in the academic environment (Narayanan, 2003).

Universities, Colleges and Educational institutions do not adapt to change easily. Their traditional infrastructures call for ideas that are much more likely to foster stability rather than change. In spite of this, one should recognize that things are changing for the better, in many cases. Now-a-days Universities are showing greater interest in the teaching activities of its faculty members, and Lilly Conference on College Teaching is a classic example. Opportunities are being provided for teachers to learn more about the *scholarship of teaching*. Foundations, endowments and grants have been supporting initiatives aimed at improving classroom teaching.

Deming's 14 points

The 14 points are a basis for transformation of American industry. Adoption and action on the 14 points are a signal that management intend to stay in business and aim to protect investors and jobs. Such a system formed the basis for lessons for top management in Japan in 1950 and in subsequent years.

The 14 points apply anywhere, to small organizations as well as to large ones, to the service industry as well as to manufacturing. They apply to a division within a company. They have been reproduced here for sake of completeness and clarity.

Source: http://www.ifm.eng.cam.ac.uk/dstools/process/deming.html

1. Create constancy of purpose toward improvement of product and service, with the aim to become competitive and to stay in business, and to provide jobs.

2. Adopt the new philosophy. We are in a new economic age. Western management must awaken to the challenge, must learn their responsibilities, and take on leadership for change.

3. Cease dependence on inspection to achieve quality. Eliminate the need for inspection on a mass basis by building quality into the product in the first place.

4. End the practice of awarding business on the basis of price tag. Instead, minimize total cost. Move towards a single supplier for any one item, on a long-term relationship of loyalty and trust.

5. Improve constantly and forever the system of production and service, to improve quality and productivity, and thus constantly decrease costs.

6. Institute training on the job.

7. Institute leadership. The aim of supervision should be to help people and machines and gadgets to do a better job. Supervision of management is in need of an overhaul, as well as supervision of production workers.

8. Drive out fear, so that everyone may work effectively for the company.

9. Break down barriers between departments. People in research, design, sales, and production must work as a team, to foresee problems of production and in use that may be encountered with the product or service.

10. Eliminate slogans, exhortations, and targets for the workforce asking for zero defects and new levels of productivity. Such exhortations only create adversarial relationships, as the bulk of the causes of low quality and low productivity belong to the system and thus lie beyond the power of the work force.

11. a. Eliminate work standards (quotas) on the factory floor. Substitute leadership.
b. Eliminate management by objective. Eliminate management by numbers, numerical goals. Substitute leadership.

12. a. Remove barriers that rob the hourly paid worker of his right to pride in workmanship. The responsibility of supervisors must be changed from sheer numbers to quality.
b. Remove barriers that rob people in management and engineering of their right to pride in workmanship. This means, inter alia, abolishment of the annual or merit rating and management by objective.

13. Institute a vigorous program of education and self-improvement.

14. Put everybody in the company to work to accomplish the transformation. The transformation is everybody's job.

Principles of Assessment

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. Furthermore, it may take several more years (in addition to the estimated five years) for the benefits to be substantially reflected in stock price. Some have also criticized TQM for not generating enough benefits as demonstrated through increased stock price
performance. One researcher also raised the question: *Is TQM Dead?* In this presentation, the author tries to address some of these issues as viewed by the Manufacturing Industry. When TQM is applied to an educational organization, one must recognize the fact that it takes several years for it to permeate throughout the entire university administrative structure. It may take much more time for its benefits to be reaped by students and the learning community.

In his previous presentation at the 110th ASEE Conference in Nashville, Tennessee, the author had re-examined university teaching strategies to support teaching innovations and classroom excellence. He had applied some of the principles of Total Quality Management to classroom teaching with a view to facilitate better classroom management and increased student participation (Narayanan, 2003). The author reported on his findings while applying a set of twenty principles while teaching a senior level engineering course. He re-visited the learning pyramid and examined its usefulness while discussing an engineering subject matter. He had used the principles of TQM to investigate ways to promote good teaching and raised a number of issues about supporting innovative and creative teaching methods in an institution of higher learning.

Based on those findings and classroom experiences, he had concluded that a culture of creative changes and significant teaching improvements could be accomplished by applying some of the principles of TQM to the classroom experience across a university. Total Quality Management or T.Q.M. is a new idea based on existing philosophies and techniques (Parker, 1996). The movement is a reaction of United States companies in response to declining productivity and sales in the worldwide trade market due to inferior quality. Total quality management is a series of procedures and philosophies taken to create an environment, or culture, of success. It is essentially a concept or philosophy for managing operations (Krabbe, 1996). It is a set of action-oriented principles and practical ideas for effective classroom management. It is a framework for improving the way in which the teachers and learners interact. It is *new* culture, a mind-set. It is a prescription for organizational effectiveness (Narayanan, 2003).

Data Collection

The method used for data collection and recording was *student portfolio analysis.* The author taught a course in Hydraulics and Fluid Mechanics during the academic year Spring 2000.   Twenty four students took the course and data was collected from those 24 students.   In order to make sure that data collection is authentic and efficient, the author required and mandated that all the students create a systematically organized student course portfolio. This portfolio clearly documents every activity in its entirety and complete detail.   Whether it be a homework assignment, or an examination or a quiz or a lab report this can be found in the portfolio at an appropriate location.   This portfolio further ensures that there is abundance of data available when needed.   Upon examination of these portfolios the author recorded twenty characteristics that he considered important for the purposes of this study.   The **20** characteristics chosen by the author was based on Deming's 14 points that pertained to TQM.

This was recorded in a spreadsheet form as shown in Appendix **B.**   These portfolios can also be graded, evaluated and assessed using a variety of rubrics and assessment tools. The author has previously presented some of these results in a form at the 114th ASEE Annual Conference in Honolulu, Hawaii (Narayanan 2007).   The author plans to generate and utilize a rubric for purposes of holistic assessment.   This rubric is based on Washington State University's Critical Thinking Project.   This is shown in Appendix **D.**

The **20** characteristics chosen by the author are recorded and incorporated into an excel spreadsheet for documenting collected data, which is shown in Appendix **B.**

A bar chart was generated based on likert scale and this is shown in Appendix **C.**

Data Analysis

Referring to the bar chart, one can draw certain conclusions and make these following important observations.

It is interesting to note that none of the characteristics observed secured the maximum possible likert scale score of **5.**   We should also observe that none of the characteristics studied secured the minimum possible likert scale score of **1.**

Five characteristics have recorded an acceptable score of **4** on Likert Scale, indicating that there is enough of room for improvement.   These characteristics are:

- Reduce dependence on lectures
- Employ modern methods

- Feedback and communication
- Recognition and keeping the score
- Identification of accomplishments

Six other characteristics have recorded an average score of **3** on Likert Scale, indicating that there is plenty of room for improvement. The instructor should focus on these areas and try to bring it up to a level of **4** on the likert scale. These characteristics are:

- Breakdown all barriers
- Adopt the new philosophy of quality
- Establish targets and goals
- Organize to reach goals
- Prevention vs. correction
- Maintain momentum
- Fact based decisions

Nine other remaining characteristics have recorded an unacceptable score of **2** on Likert Scale. This leads us to conclude that there has been inadequate effort. This may be indicative that the instructor should realign his strategies and communicate with the students more effectively. These characteristics must show improvement and move towards a likert scale score of **3.**

Conclusions

Based on the bar chart shown in Appendix C, one can conclude that group dynamics is indeed very important in almost all areas. The students are also very capable of using modern technology and software for recording and analyzing data collected. The student body in general, do support diverse learning techniques. They also provide encouragement in creating a supportive educational environment.

As regards the educational aspects of TQM one can draw multiple conclusions based on the bar chart recorded Appendix **C.** There is a definite need for improvement in a variety of areas. These have been discussed separately in detail under "Data Analysis."

In summary, the author acknowledges that more research is required to examine in detail the benefits of TQM. Lively classroom discussions have shown to allow greater student participation. Although, some scholars say that such a method puts forth a completely different approach to college education compared to a traditional lecture format (Midgley, 2002). TQM should lead the path and provide a constructive approach to university learning experience.

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Appendix A: Author's Approach for Implementing TQM in Classroom Activities.

Continuous Improvement

TQM Principles

5

1

2

Select W.S.U. Rubric

Draw Conclusions

4

3

Analyze Data Collected
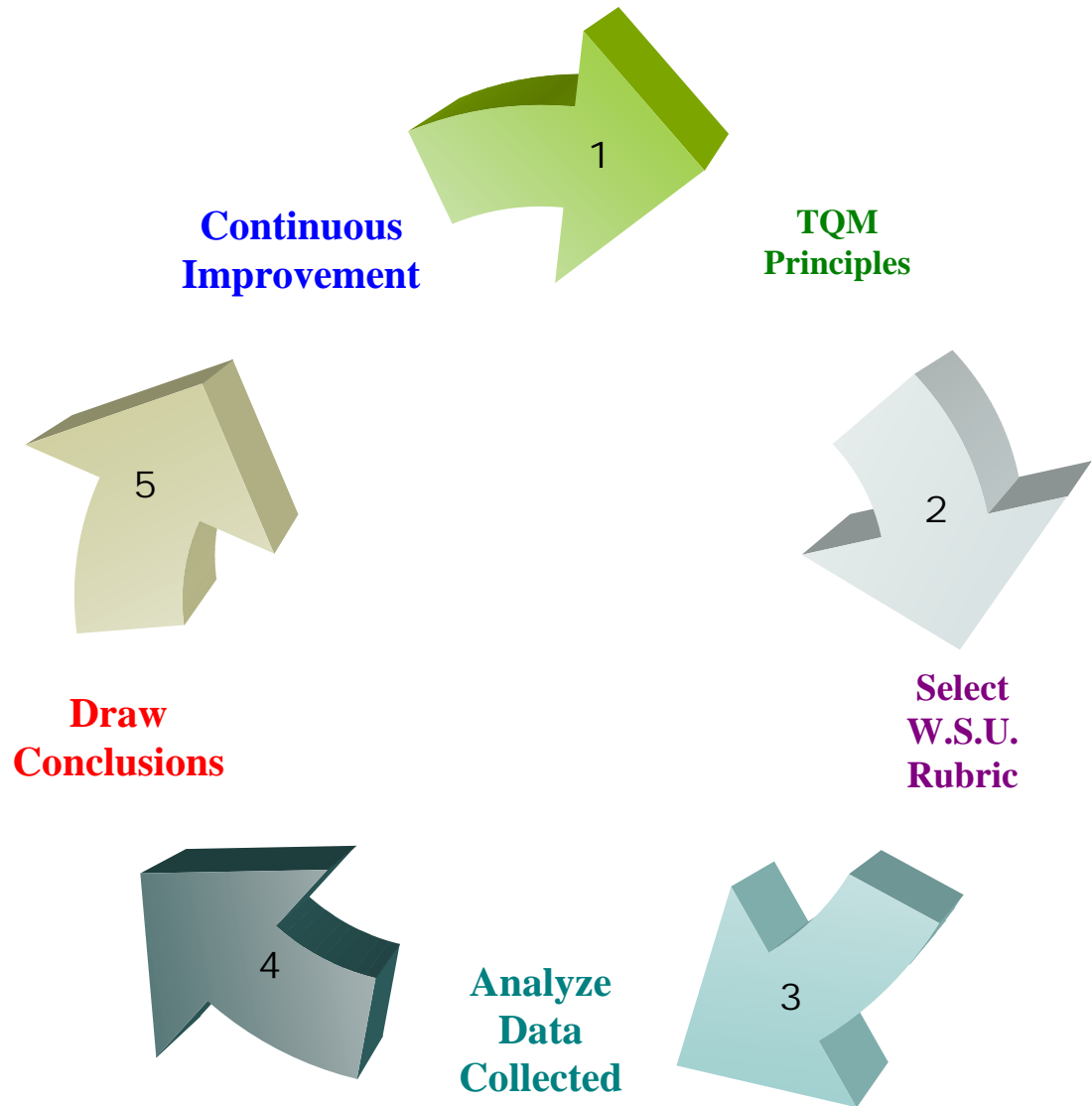
The author has previously used this *'cycle'* in other ASEE publications.

APPENDIX B : Sample Spreadsheet for Collecting Data

STUDENT # X

T Q M RUBRIC: FLUID MECHANICS
RUBRIC BASED ON THE PRINCIPLES OF
CRITICAL THINKING RUBRIC
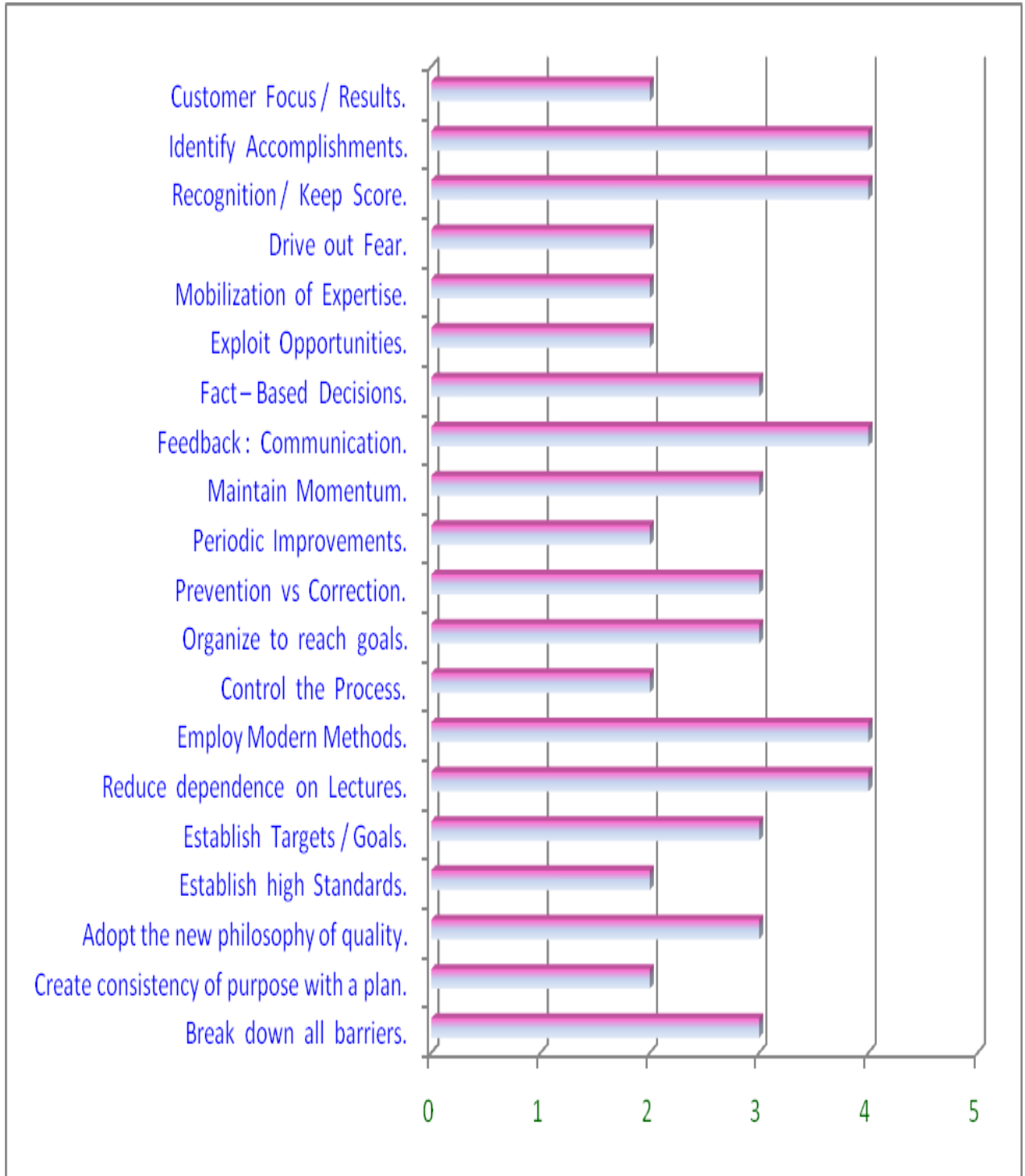COURTESY OF W. S. U.
WASHINGTON STATE UNIVERSITY
PULLMAN, WA. 99164.
LIKERT SCALE WEIGHT DISTRIBUTION :

		5	4	3	2	1
1	Break down all barriers.		√			
2	Create consistency of purpose with a plan.				√	
3	Adopt the new philosophy of quality.		√			
4	Establish high Standards.			√		
5	Establish Targets / Goals.			√		
6	Reduce dependence on Lectures.				√	
7	Employ Modern Methods.			√		
8	Control the Process.		√			
9	Organize to reach goals.				√	
10	Prevention vs Correction.		√			
11	Periodic Improvements.		√			
12	Maintain Momentum.			√		
13	Feedback : Communication.				√	
14	Fact – Based Decisions.		√			
15	Exploit Opportunities.		√			
16	Mobilization of Expertise.			√		
17	Drive out Fear.			√		
18	Recognition / Keep Score.		√			
19	Identify Accomplishments.				√	
20	Customer Focus / Results.		√			

LIKERT SCALE: 5: STRONGLY AGREE

1: STRONGLY DISAGREE

APPENDIX C : Sample Bar Chart

APPENDIX D : Critical Thinking Rubrics (Courtesy of W.S.U., Pullman, WA)

LIKERT SCALE   **5: STRONGLY AGREE.   1: STRONGLY DISAGREE**

5

Has demonstrated excellence.
Has provided documentation.
Evidence of critical thinking ability.
Very good performance

Has analyzed important data precisely.
Has answered key questions correctly.
Has addressed problems effectively.
Has evaluated material with proper insight.
Has used deductive reasoning skills.
Has used inductive reasoning skills.
Has employed problem solving skills.
Has discussed consequences of decisions.
Has been consistent with inference.

3

Has demonstrated competency.
Adequate documentation.
Critical thinking ability exists.
Acceptable performance.

Data analysis can be improved.
More effort to address key questions.
Need to address problems effectively.
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.
Lacks critical thinking ability.

Absence of analytical skills.
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, P.O. Box 644530, Pullman, WA 99164 - 4530 USA.(2005)   http://wsuctproject.wsu.edu/ctr.htm

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