Holistic Use of TOC in a University

Umesh Nagarkatte, Professor and Chair, Department of Mathematics
Medgar Evers College, CUNY,
Brooklyn, NY 11225

Friday 10/19/2012
10:00-10:50 AM

Assisted by: Nancy Oley – Professor, Department of Psychology
Goal:

Inform the academics around the world on:

1. how a Department of Mathematics applied TOC and Its Thinking Process Tools for student retention.
2. how to involve all stake-holders in student success.
3. how to empower students to resolve conflicts, solve problems and make decisions in personal or academic life.
4. TOC resources available for academia.
Overview

- Background
- The TOC Thinking Processes Roadmap
- Unique Features of the College Scene
- Grants awarded for this work
- Impact of training in Theory of Constraints and Thinking Process tools
- Ongoing Activities
- Summary
School of Science Building
Medgar Evers College, CUNY
Background – Student Body

- 6,900 - 66% fulltime, 98% minority, 75% women
- African-Americans: 91%, Hispanics: 4%, Native Americans: 0.1%
- Average age 28, ranging from 18 to 60.
- 50% need competency in basic writing skills, 88% in mathematics, 32% in reading
- 51% did not continue. 45% freshmen did not return.
- Students have only one year to overcome their deficiencies in mathematics and English through remedial courses.
The College and the Department have studied the problem of attrition and suggested remedies since 1978.

No amount of curriculum development or technology is useful, if student’s mind is not there. We learned this hard way. Any curriculum improvement is short-lived or local to the initiator or a few of his colleagues.

In 1998, the College Faculty Senate published a document developed by the college-wide faculty identifying 26 issues of academic and non-academic nature to overcome attrition and failure.

They suggested one remedy for each issue, naming the respective Department to carry out the activity.

But addressing the 26 issues individually is an impossible task because of logistics, coordination, accountability, duplication and resources. Some of the issues are listed on the next slides.
Student Survey Issues (UDEs)

1. The instructor moves too fast for students.
2. The instructor knows his subject matter but cannot teach.
3. I am not capable of doing mathematics.
4. I am not prepared for course (prerequisites for class).
5. I don’t have time to do the homework.
6. I don’t see importance/relevance of mathematics.
7. I am unable to attend class regularly and/or on time.
8. The exams are too hard.
9. I have to take care of my family/personal problems.
10. I (some students) go blank on exams (poor test-taker).
11. The instructor does not care about me.
12. There isn’t help outside of class when I’m free.
Faculty/Instructor Issues

1. Students do not prepare for class.
2. Students don’t attend regularly or on time.
3. Students do poorly on tests.
4. There is not sufficient time to cover all material in the course.
5. Students register late for semester. They don’t start at the beginning of the semester.
6. Students do not have prerequisites for class.
7. Students aren’t learning effectively.
8. I receive very little satisfaction from my work.
9. We feel pressure to pass students who are not adequately prepared for the next course.
10. Students haven’t mastered all the prerequisite topics needed for my course.
Department Chair Issues

1. There is a lack of cooperation by some faculty to carry out departmental agenda.
2. Too many students fail.
3. There is insufficient input by some faculty to address major departmental issues.
4. Some faculty are apathetic.
Background – Previous Efforts to address attrition using TOC

- 2001 – US Dept. Education grant - Minority Science and Engineering Program (MSEIP) for $300,000 was funded for formal training in TOC and implementation.

- Hypothesis: Theory of Constraints (TOC) can address the problems with student retention in the Department of Mathematics.

- January 2002 - Three faculty members from Department of Mathematics – Darius Movasasseghi, Chair, Umesh Nagarkatte and Joshua Berenbom took the Jonah Course at AGI, New Haven, CT.

- The Process of OnGoing Improvement (POOGI) of implementing TOC to address attrition has been going on ever since.
Dedicated Jonah Program – Jan. 2002

A salute to our facilitators at AGI – Tracy Burton-Houle, Steve Simpliciano with Darius Movaseghi, Joshua Berenbom, Umesh Nagarkatte
Span of Control

1. Any improvement can only be made in the area of one’s control and/or in the area under one’s responsibility.

2. One must start with the area of control, because rapid progress is possible in areas about which one has intuition and expertise.
Unlike industry and primary or secondary school, no professor will adopt new methods of instruction, however great, by a ruling of the department chair or a college administrator.

Considering union regulations and academic freedom, senior faculty do not feel obligated to accept any modifications in their normal activities and change in the curriculum.

Any perceived activity extraneous to instruction is usually by regarded as an impediment. Thus faculty acceptance of any new initiative is of paramount importance in a college setting.
1. **What to Change?**
Identifying the Problem

**Analysis**

1. **Three-Cloud Process:** What core conflict is responsible for the UDEs?

2. **Current Reality Tree:** Is the core conflict really the core conflict?

3. **Evaporating Cloud:** What assumption(s) are we going to challenge?

2. **What to Change To?**
Constructing the Solution

**Strategy**

4. **Future Reality Tree:** Ensures that the starting injection will lead to all the DEs without creating negative branches.

3. **How to Cause a Change?**
Designing the Implementation

6. **Transition Trees:** What actions must we take to implement the PreRequisite Tree?

5. **PreRequisite Tree:** In what order do we implement the T.O.s and what blocks their implementation?
1. What to Change?
Identifying the Problem

0. Why change? – Define system, goal, gaps, UnDesirable Effects (UDEs)

1. Three-Cloud Process: What core conflict is responsible for the UDEs?

2. Current Reality Tree: Is the core conflict really the core conflict?

3. Evaporating Cloud: What assumption(s) are we going to challenge?
System -

- All stakeholders in student success
  - Student
  - Instructor
  - Chair
  - Tutor
  - Counselor/Advisor
  - Friends and Family
Evaporating Cloud # 1

Issue #5: “I don’t have time to do the homework.”

A. Be a responsible person.

B. Have time to fulfill other obligations.

C. Learn the material.

D. Not do the homework.

D’. Do the homework (on time).

Common Objective

In order to …

I must

Requirements/Critical Needs

Have time to fulfill other obligations.

In order to …

I must

Prerequisites/Means/wants

Not do the homework.

Do the homework (on time).

But at the same time, in order to …

Conflict!
Evaporating Cloud # 2.

Issue # 7: “I am unable to attend regularly and/or on time.”

- Be a responsible person.
- Fulfill obligations.
- Learn the material.
- Attend regularly.
- Not attend regularly.

Conflict!
Evaporating Cloud # 3

Issue #12: “There isn’t help outside of class when I’m free.”

- Do well in course.
- Understand everything on my own.
- Solve my difficulties as they arise.
- Get help.

Conflict!
Root Cause of Students' Issues

Issue #5
Be a responsible person.

- Have time to fulfill other obligations.
- Learn the material.
- Fulfill obligations.
- Attend regularly.

Issue #7
Be a responsible person.

- Not do the homework.
- Do the homework (on time).
- Learn the material.
- Attend regularly.

Issue #12
Do well in course.

- Understand everything on my own.
- Solve my difficulties as they arise.
- Get help.
- Not get help.

- Be successful & responsible person.
- Fulfill all obligations.
- Learn the material.
- Do the required activities for my math class(es).

- Have time to fulfill other obligations.
- Do the homework (on time).
- Learn the material.
- Attend regularly.

- Not do the homework.
- Do the homework (on time).
- Learn the material.
- Attend regularly.
Core Conflict: I cannot do the required activities for my math class.

- They don’t get fulfilled on their own.
- I have to take time from math to do those things.
- There is no one else to fulfill my other obligations.
- My other obligations can’t/won’t go away.
- I can’t postpone my other obligations.

- I can only learn material by persevering in math.
- I must do and hand in assignments to learn.
- I must find the time to do the assignments.
- I must do work on time.
- I must study.
- I must develop study skills.
- I must work - do the work to learn the material.
- I must do the work outside of class to learn the material.
- I have to physically be in class during set times.

Not do the required activities for my math class(es).

Do the required activities for math class(es).

Learn the material.

Fulfill other obligations.

Be successful & responsible person.
Addressing the Root Cause of Student Survey Issues

The starting point for a viable strategy...

“The department offers programs tailored to the needs of its students.”

D to D’:

- I can’t fulfill other obligations & math obligations at the same time.
- Focusing on mathematics distracts me from focusing on other obligations.
- My working hours and math class hours conflict.
- Math classes are not held at convenient times for students.
- Students can’t move freely from section to section.
- Classes are prof-centered, not student-centered.
- We have a structured curriculum.
- A structured curriculum doesn't permit customization or doesn't accommodate students with special needs.
- I can’t reduce the time I spend on my personal obligations (or math).
I want to be a successful and responsible person.

I must fulfill other obligations (not my math class.)

I must learn the material.

I feel pressure to fulfill my other obligations.

I feel pressure to do the required activities of my math class(es).

My load is too heavy.

I must carry a full load to get financial aid.

Students register late and don't start at beginning of semester.

I do not have time to do the homework/or prepare for the course.

I do not know how to manage my time.

My math instructor does not help me realize relevance of math I am taking.

I do not see importance / relevance of mathematics I am taking.

I am unable to attend regularly and/or on time.

Instructor does not help me. (e.g. does not respond to my questions, etc.)

Students/I do poorly on tests.

I feel the exam too hard.

I cannot get help outside of the class when I am free.

I percieve I cam not capable of doing mathematics.

Sometimes the instructor slows down.

There is insufficient instruction in test taking skills.

I feel the instructor goes too fast.

I feel the instructor cannot teach.

I feel the exam too hard.

I feel the instructor does not care from me.

I feel the exam too hard.

Incompletes are given incorrectly.

There are too many incompletes.

Students don't graduate on time.

There are too many students fail.

Students don't graduate on time.

Students I do poorly on tests.

I feel the exam too hard.

Students don't graduate on time.

Students don't graduate on time.

Students don't graduate on time.
Negative Loops in CRT

- I feel pressure to fulfill my other obligations.
- I do not work hard in math.
- I cannot follow the lecture.
- I have difficulty learning the material (in math classes.)
- I have difficulty taking tests.
- I feel the exam too hard.
- I feel the instructor does not care from me.
- I am unable to attend regularly and/or on time.
- I feel the instructor goes too fast.
- I am not motivated to learn the material.
- Students/I do poorly on tests.

Intervention

- I perceive I am not capable of doing mathematics.
- I cannot follow the lecture.
- I do not work hard in math.
- I feel pressure to fulfill my other obligations.
2. What to Change to? Constructing the Solution

3. Evaporating Cloud: What assumption(s) are we going to challenge?

4. Listing DEs

5. Future Reality Tree: Ensures that the starting injection will lead to all the DEs without creating negative branches.
Students’ Issues  Desired Effects (DEs)

1. The instructor moves too fast for students.
2. The instructor cannot teach.
3. Students are not capable of doing mathematics.
4. Students are not prepared for course (prerequisites for class).
5. I don’t have time to do the homework.
6. I don’t see importance/relevance of mathematics.
7. I am unable to attend class regularly and/or on time.
8. Students do poorly on tests.
9. I have to take care of my family/personal problems.
10. The instructor does not care about me.
11. There isn’t help outside of class when I’m free.
12. I don’t know how to graduate from college.
13. My course load is too heavy (I’m forced to be full time in order to get financial aid).
14. I do not know how to get good grades in important courses.
15. I cannot drop a class without jeopardizing my financial aid.
16. I am forced to ask for incompletes.

1. Instructor moves at a comfortable pace.
2. Students are satisfied with the instructor’s teaching style.
3. Students do mathematics well.
4. Students have all prerequisites for the course.
5. Students finish all homework on time.
6. Students feel math is relevant for their career.
7. Students are punctual.
8. Students do well on tests.
9. I take care of my family/personal problems.
10. Instructor helps me to keep up with the course.
11. There is adequate help when I need it.
12. I have sufficient knowledge/help to plan my college career.
13. I can handle my course load.
14. I get good grades in important courses.
15. I do not need to drop any class.
16. I am able to complete the course.
Faculty/Instructor Issues

Desired Effects (DEs)

21. Students do not prepare for class.
22. Students don’t attend regularly or on time.
23. Students do poorly on tests.
24. There is not sufficient time to cover all material in the course.
25. Students register late for semester, and don’t start at the beginning of the semester.
26. Students do not have prerequisites for class.

24. There is sufficient time to cover all material in the course.
25. All students begin at the start of the semester.

Department Chair Issues

27. There is a lack of cooperation by some faculty to carry out departmental agenda.
28. Too many students fail.
29. There is insufficient input by some faculty to address major departmental issues.
30. Some faculty are apathetic.

28. There is a high rate of passing.
Desired Effects (DEs)
Strategic Objectives (SOs)

24. There is sufficient time to cover all material in the course.
25. All students begin at the start of the semester.
28. There is a high rate of passing.
33. There are very few Incompletes.
34. Most students graduate on time.
35. Few students drop out of classes.
36. Student achievement is high.
37. Students perform well on exams.

33. There are absolutely no Incompletes.
36. Retention in the Department/Program is high.
Future Reality Tree (FRT) (pages 1, 2)

- **Student DE's**
  - Student DE's
  - Existing/Intern. steps
  - Injections

- **Existing/Intern. steps**
  - Student DE's
  - Injections

- **Injections**
  - Student DE's
  - Existing/Intern. steps
  - Injections

Legend:
- S: students
  - DE's: Department
  - I: instructor
  - D: dept
  - C: college

Legend:
- S: students
- DE's: Department
- I: instructor
- D: dept
- C: college

*1* Late registrants 18 students who have not taken required math courses in the past are provided refresher.

*2* Tutors show up on time.

*3* Students do mathematics well on tests.

*4* Students do well on tests.

*5* Students get the math they need for college.

*6* Student's workload is realistic and accommodates their finances.

*7* Students feel the instructor moves at a comfortable pace.

*8* Students do well on tests.

*9* Students finish all homework on time.

*10* Students have all the prerequisites.

*11* Students are confident that they can complete course work successfully.

*12* Students are satisfied with instructors' style.

*13* Students feel the instructor moves at a comfortable pace.

*14* Students do not need to drop any courses.

*15* Students feel math is relevant for their careers.

*16* Students do their work.

*17* Students are satisfied with their instructors.

*18* Math instructors are well prepared.

*19* Students have the math they need for math dependent courses.

*20* Math instructors are involved in informing/ training tutors in how to do their work.

*21* Students are satisfied with instructors' style.

*22* Students feel the instructor moves at a comfortable pace.

*23* Students are satisfied with their instructors.

*24* Students do their work.

*25* Students feel math is relevant for their careers.

*26* Students are satisfied with their instructors.

*27* Students do their work.

*28* Students feel math is relevant for their careers.

*29* Students are satisfied with their instructors.

*30* Students do their work.

Future Reality Tree

Student DE's

Existing/Intern. steps

Injections

Legend:
- S: students
  - DE's: Department
  - I: instructor
  - D: dept
  - C: college
The department becomes a "Center of Excellence."

Students graduate on time/completes math major.

Faculty morale improves.

Students incorporate math in their career and daily life.

There is time for review and enrichment.

Retention in dept./program is high.

More students become math majors.

Students seek to take more math courses.

Students graduate on time/complete math major.
Sustaining Instruction / tutoring / counseling Loops in FRT

Instruction and Tutoring

Reinforcement: Prep for tests

- **8** Students do well on tests.
- **3** Students do mathematics well.
- **4** Students have all the prerequisites for the courses.
- **5** Students finish all homework on time.
- **7** Students are punctual and attend all classes.
- **12** Students get the supplemental instruction they need when needed.

Reinforcement: Writing components.

- **12** Students are confident that they can complete homework successfully.
- **19** Students do well on tests.
- **14** Students can handle course load.

Counseling

- **18** Students are ready to understand the lecture.
- **16** Students are punctual and attend all classes.
- **19** Students do not need to drop any classes or ask for incomplete.
- **14** Students have all the prerequisites for the courses.
- **15** Students do well on tests.
- **13** Students do not need to drop any classes or ask for incomplete.

SI Department offers programs tailored to the needs of students.

- **100** SI Department offers programs tailored to the needs of students.
- **162** Classes are scheduled to accommodate students.
- **120** Lecture is closely related to syllabus.
- **130** Class time prepares students well for doing homework/assignments.
- **115** Advisers advise students to take realistic and challenging course loads.
- **117** Counselors get involved when student does not attend.
- **117A** There is a mechanism for providing communication with instructors and students' counselors.

Classes are scheduled to accommodate students.

- **145** College provides adequate help in terms of tutorial and drop in centers.
- **190** Instructors take an active role in developing study, homework and test-taking skills.
- **162** College provides adequate help in terms of tutorial and drop-in centers.

Students learn all expected and necessary material.

- **200** Students learn all expected and necessary material.
- **192** Students are confident that they can complete homework successfully.
- **187** Students are punctual and attend all classes.
- **130** Class time prepares students well for doing homework/assignments.
- **120** Lectures are closely related to syllabus.

Advisors advise students to take realistic and challenging course loads.

- **165** Advisers advise students to take realistic and challenging course loads.
- **117** Counselors get involved when student does not attend.
- **117A** There is a mechanism for providing communication with instructors and students' counselors.

Instructors take an active role in developing study, homework and test-taking skills.

- **190** Instructors take an active role in developing study, homework and test-taking skills.
- **145** College provides adequate help in terms of tutorial and drop in centers.
- **162** Classes are scheduled to accommodate students.
- **120** Lecture is closely related to syllabus.
- **130** Classtime prepares students well for doing homework/assignments.

College provides adequate help in terms of tutorial and drop in centers.

- **145** College provides adequate help in terms of tutorial and drop in centers.
- **162** Classes are scheduled to accommodate students.
- **120** Lecture is closely related to syllabus.
- **130** Classtime prepares students well for doing homework/assignments.

Classes are scheduled to accommodate students.

- **162** Classes are scheduled to accommodate students.
- **120** Lecture is closely related to syllabus.
- **130** Classtime prepares students well for doing homework/assignments.
- **120** Lecture is closely related to syllabus.

Lecture is closely related to syllabus.

- **120** Lecture is closely related to syllabus.
- **130** Classtime prepares students well for doing homework/assignments.
- **120** Lecture is closely related to syllabus.
- **130** Classtime prepares students well for doing homework/assignments.

Instructors take an active role in developing study, homework and test-taking skills.

- **190** Instructors take an active role in developing study, homework and test-taking skills.
- **145** College provides adequate help in terms of tutorial and drop in centers.
- **162** Classes are scheduled to accommodate students.
- **120** Lecture is closely related to syllabus.
- **130** Classtime prepares students well for doing homework/assignments.

Advisors advise students to take realistic and challenging course loads.

- **165** Advisers advise students to take realistic and challenging course loads.
- **117** Counselors get involved when student does not attend.
- **117A** There is a mechanism for providing communication with instructors and students' counselors.

Counselors get involved when student does not attend.

- **117** Counselors get involved when student does not attend.
- **117A** There is a mechanism for providing communication with instructors and students' counselors.
- **165** Advisers advise students to take realistic and challenging course loads.
- **117** Counselors get involved when student does not attend.
- **117A** There is a mechanism for providing communication with instructors and students' counselors.

There is a mechanism for providing communication with instructors and students' counselors.

- **117A** There is a mechanism for providing communication with instructors and students' counselors.
- **165** Advisers advise students to take realistic and challenging course loads.
- **117** Counselors get involved when student does not attend.
- **117A** There is a mechanism for providing communication with instructors and students' counselors.

Advisors advise students to take realistic and challenging course loads.

- **165** Advisers advise students to take realistic and challenging course loads.
- **117** Counselors get involved when student does not attend.
- **117A** There is a mechanism for providing communication with instructors and students' counselors.
- **165** Advisers advise students to take realistic and challenging course loads.
- **117** Counselors get involved when student does not attend.
- **117A** There is a mechanism for providing communication with instructors and students' counselors.
Example: Negative Branch Reservations (NBRs) \( \textit{NBR on Entity 180:} \)

Students have realistic Schedules.

- Students drop out.
  - Students motivation and stick-to-itiveness drops.
    - Students take longer to graduate.
      - Many students take fewer credits per semester.
        - Students have other commitments.
          - Students have realistic schedules.

- Students have insufficient income.
  - The amount of student aid is reduced.
    - Students work less.
      - Given today’s class support, students have to spend too much time struggling on their own to complete work for class.

Counseling and support activities (assist students)

- Offer more required courses in summer.
  - Provide $ support to students.

Supplemental instruction, child care services, counselors
3. How to Cause a Change?  
Designing the Implementation

5. Future Reality Tree: Ensures that the starting injection will lead to all the DEs without creating negative branches.

6. PreRequisite Tree: In what order do we implement the T.O.s and what blocks their implementation?

7. Project Plan

8. Transition Trees: What actions must we take to implement the PreRequisite Tree?
Concerns that there are obstacles that will block us from achieving the solutions’ tactical objectives...

1. Because...
   - Math Dept does not have enough tutors available.

2. We must first...
   - Tutor Center doesn’t make allowances or provisions for last minute contingencies.

3. Before we can have...
   - Tutors don’t follow established policy for absenteeism.

145A (Tactical Objective)
(Alternate) Tutors show up and are on time.

145A.1 Math Department has enough qualified tutors available.
145A.2 Math Department recruits and encourages tutors.
145A.3 Tutors understand their role and contribution to peers.

Tutors aren’t disciplined about showing up on time or being present.
Getting Active Collaboration

**Identifying what we need to get cooperation**

How should we think about achieving Intermediate Objective 110.1?

- **110.1 (Tactical Objective)**
  - Department provides guidelines/policies for instruction.

- **110.2**
  - Faculty committee writes the guidelines.

- **Faculty may object to any guidelines.**
- **We don’t agree on what defines the guidelines.**

- **110.1**
  - Have consensus on what goes into guidelines.

- **Should we have guidelines (especially for adjuncts)?**
- **What guidelines/topics should we have, and what should these guidelines include?**
- **Create committee to write guidelines**
- **Process for writing/creating guidelines**
Prerequisite Tree (PRT p.3-p.4)
Substitutes are readily available when needed.

112.1 Dept establishes a contact phone number and someone to run it.

112.2 Dept establishes a pool of substitutes and a pool of substitutes is available.

112.3 The College provides funds to pay for adjuncts.

112.4 Dept establishes policy on cancelled classes.

195.1 Dept establishes guidelines on timely feedback.

110 Department provides guidelines for instruction.

* No review
* Complete syllabus
* Keep pace
* What section/date/schedule
* Final exam is comprehensive.

170.1 Counselors/advisors get available hours and obligations to create his/her schedule.

170.2 Only students with advisors approval are allowed to register.

175.1 College mandates that schedule reflect students academic performance and not on financial need.

175.2 Dept guidelines inform instructors proper procedures for late registrants.

176 Students workload is based on academic performance and not on financial need.

177 Instructors inform counselors of absences or problems of students.

177A Instructors inform counselors excessive student absences.

177A.1 Dept guidelines provide guidance and instructions for contacting students.

177A.2 Dept guidelines require instructor to contact counselors of suspected student problems.

178 Math instructors inform late registrants to take supplementary instruction on the first day of attendance.

179 Counselors get involved when student does not attend.

179A There is a mechanism for providing communication with instructors and students counselors.

181 Students receive timely feedback, discussion, etc. on homework.

100 GOAL SI Department offers programs tailored to the needs of students.

105 We have ideal financial, academic, supplemental instruction, career and personal advisement and counseling when needed.

117 Counselors get involved when student does not attend.

117.1 Instructors inform counselors excessive student absences.

117.2 Dept guidelines provide guidance and instructions for contacting students.

117.3 Instructor informs counselors of suspected student problems.

141 Late registrants are required to do adequate supplemental instruction to be current with the class.

141.1 Math instructors inform late registrants to take supplementary instruction on the first day of attendance.

141.2 Dept guidelines inform instructors proper procedures for late registrants.

191 Instructors are actively involved getting students to make use of Supplementary Instruction and Tutorial centers.

195 Students receive timely feedback, discussion, etc. on homework.

121 Students receive comprehensive academic services to deal with any math-related difficulties.
Tutors, Supplemental Instruction

114. Info. is readily available and disseminated in a variety of forms concerning support services.

205. Dept makes prelude/practice tests available with feedback and assistance.

220. Math instructors are involved in informing/training tutors in how to do their work.

170. Counselors and advisors inform students about the importance of supplemental instruction.

212. There is a mechanism in place for math dept to contact other depts informing them of availability of brushup workshops.

191. Dept obtains money to pay adjuncts to attend.

121. Students receive comprehensive academic services to deal with any math-related difficulties.

110. Department provides guidelines for instruction.

114. Dept guidelines inform the instructor how to make use of drop-in centers.

140. Faculty hold appropriate office hours.

121. Dept seeks funding from outside college to establish drop-in centers.

145A. Dept. seeks funding.

121. College provides adequate help in terms of tutorial and drop in centers.

140. Adjunct Faculty schedule office hours/appointments to accommodate students.

191. Facilities are set up to hold workshops.

110. Math Dept has enough tutors available.

140A. Math Dept has enough tutors available.

141. Math instructors are actively involved getting students to make use of Supplementary Instruction and Tutorial centers.

145A. Tutors understand their role and contribution to students.

141. Instructors are convinced of the benefits of effective tutoring in their work related to their instructional tasks.

121. Students are encouraged and pressured to use drop-in center and tutoring center.

140A. Tutors show up on time.

121. Students are informed by syllabus and instructor of availability of drop-in center and tutorial center.

191. Students are informed by syllabus and instructor of availability of drop-in center.

145A. Tutors show up on time.

121. Students are actively involved getting students to make use of Supplementary Instruction and Tutorial centers.

145. College provides adequate help in terms of tutorial and drop in centers.

145A. Dept recruits and encourages tutors.
Buy-in by the Department

- Spring 2002 - Dr. Movasaseghi, Chair, spent 15 min. of each department meeting explaining what the TOC team had learned in the two week training. By the end of the semester the department faculty accepted TOC.
- Summer 2002 - This led to the development of Departmental Guidelines that are still in use.
- Congenial environment developed which continues.
- Students receive immediate help through drop-in tutoring center in the Department.
- Fall 2002 - # Majors went from 7 to 29 in Fall 2002; 40 now enrolled.
- Upto 2012 - # BS Math graduates = 35 (OIR data)
- Several went for doctoral studies and into HS teaching.
The work that we describe has been supported by 6 Federal grants to the Math Dept, and has actively involved at least 325 faculty, students, staff and administrators since 2001.

- MSEIP 2001-2004 $300,000
- MSEIP 2004-2007 $300,000
- WEEA 2005-2007 $320,000
- MSEIP 2010-2013 $600,000
- MSEIP 2010-2013 $900,000- (Cooperative with QCC)
- MSEIP 2012-2015 $652,218

Total $3,072,218
A system-wide solution

“The department offers programs tailored to the needs of its students”

The starting point for a viable strategy is just the beginning.

For a system-wide solution to be effective, we must have synchronization of all support activities:

1. Faculty to instill confidence in math students and teach syllabus at comfortable pace
2. Tutors to instill confidence in math students through supplemental instructions
3. Counselors to collaborate with instructors, guide students on academic and personal conflict resolution, and create challenging yet realistic schedules
System wide efforts

- Tutor accountability has increased (show up on time and are dependable)
- Students have direct access to faculty and tutors
- Mutual communication among faculty and with students
- Motivational Guide for Students

Administrative Buy-in: The study indicated that to approach counseling/FY advisors required the Administrative buy-in which took place in May 2005. For the buy-in process of the Departmental Guidelines the college President, Dr. Edison O. Jackson, required our trainer to come and present. The buy-in process was so impressive that the President accepted the Departmental Guidelines, commended the department for considering the college’s main issue of Student attrition and not just concentrating on the academic discipline. He elevated the issue to the college level and said the middle-level management and all faculty starting with Counseling and AFD learn TOC.
# Impact on Tutoring and Counseling

<table>
<thead>
<tr>
<th>What</th>
<th>Who</th>
<th>For</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thinking Process (TP) Tools</td>
<td>Counselors and Department Faculty</td>
<td>Guide other faculty and students in problem solving, decision making, and conflict resolution</td>
</tr>
<tr>
<td>Develop Peer-to-Peer TP Tools</td>
<td>Counselors and Students</td>
<td>Mathematics Department student population</td>
</tr>
<tr>
<td>Problem solving techniques</td>
<td>Students</td>
<td>Support services such as peer tutoring, mentoring, and counseling</td>
</tr>
</tbody>
</table>
1. Curriculum Development –
   • writing components in upper level classes
   • systematic use of technology – Maple Labs
     www.calculusplus.com
   • Online help – wikis for Algebra, Finite Mathematics and Precalculus
   • Unified syllabus from Prealgebra-College Algebra
   • Adapting the Singapore Model Method
   • Textbook Development.
   • PRTs on all topics from Prealgebra to College Algebra each obstacle linked to appropriate KhanAcademy.org video/s
Singapore Mathematics Framework

- Appreciation
- Interest
- Confidence
- Perseverance

- Estimation and Approximation
- Mental calculation
- Communication
- Use of mathematical tools
- Arithmetic manipulation
- Algebraic manipulation
- Handling data

- Monitoring one’s own thinking

- Thinking skills
- Heuristics

- Numerical
- Geometrical
- Algebraic
- Statistical

11/19/2011
This website provides students and faculty with access to precalculus, calculus, linear algebra and differential equations, computer and writing projects. These projects are basic, some are novel, interesting and challenging. Important background information, if necessary, is summarized. They can be simply viewed and adapted to a suitable Computer algebra Systems software. They emphasize the numerical, graphical and verbal approach to the content of the entire course. Viewers having Maple 15 or an earlier release on their computers will be able to download and modify the projects. Process of downloading the maple files: Users must first save the mws.txt file on their computer, note the file might look gibberish, its just a maple text and it must be saved first then opened with maple 15 or an earlier release. To do this, when you open the maple program another window appears, on the left side of the window click on open file then locate where the mws.txt file was saved on your computer and click open.

These projects were created and class tested at Queensborough Community College and Medgar Evers College of the City University of New York as some of the activities of the three MSEIP collaborative grants for 1998-2001, 2001-2004, 2010-2013 and to improve student achievement in higher level mathematics courses. The projects are designed for use as cooperative learning experiences in a laboratory settings and are also interactive if Maple 15 or earlier releases are used. Some writing projects are specific to the course, some are general but all give practice on communication skills.

Since the sequence of topics in calculus varies among schools, visit all our calculus topics.

to begin, click on each menu above to view or download our projects and labs:
2. Tutoring – How to study a course as a project – Tutorial management.


4. FY course – “Creative Thinkers Toolkit – Thinking and Acting”
   Umesh Nagarkatte, Nancy Oley, Michael Fitzgerald, Sambhavi Lakshminarayanan
Resources (continued)-

5. Lesson Plans – for FY Course
   Nancy Oley assisted by Rupam Saran piloted Summer 2011 –
   Sophia Smart

How can you tap into a world-wide community to find knowledge and tools to improve education through TOC?

Think Systematically to Overcome Obstacles

Thinking is fundamental to being human. Thinking can be liberating. Thinking can be confining. When thinking is confining, it creates many obstacles making it difficult for people to attain significant goals. Theory of Constraints (TOC) helps people think systematically to overcome obstacles and create NO new ones. A constraint is the most important obstacle that
TOC Workshops

More than 325 people in the college have been exposed to TOC terminology and Thinking Processes (TP)

<table>
<thead>
<tr>
<th>FYP and AFD Area heads and grant team @AGI, CT</th>
<th>FY Advisors and AFD and Math Faculty and all tutors</th>
<th>Counselors, FY advisors and Faculty</th>
</tr>
</thead>
</table>
TOC Workshops (Continued)

President Jackson and his cabinet

Theme: Smooth Transition from FY to credit bearing courses

<table>
<thead>
<tr>
<th>MEC and QCC</th>
<th>MEC and QCC for Counselors, FY advisors and grant team</th>
<th>MEC – Math, Biology, English, FY advisors at Riverhead, NY</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 2008</td>
<td>January 2011</td>
<td>July 2011</td>
</tr>
<tr>
<td>Tuesdays 10:00-4:00</td>
<td>&amp; May 2011</td>
<td>July/ August 2012</td>
</tr>
</tbody>
</table>
With Eli Goldratt at Leon, Mexico, 9th International Conference, TOCfE, 2006
Acknowledgements -
The presenter feels indebted to

The originator of TOC – Late Eli Goldratt for personally encouraging the MEC Team

TOC Trainers – Steve Simpliciano, Tracy Burton-Houle, Howard Meeks and Avraham Goldratt Institute (AGI), New Haven, CT for providing a secluded conducive environment for rigorous training,

Kathy Suerken, Danilo Sirias, Belinda Small for TOC for Education workshops at the College,


MEC President Edison Jackson – for recognizing that implementation of TOC in the department of mathematics is in fact a college-wide endeavor.

TOCfE - Kathy Suerken - for applying TOC to education and for providing a forum for dissemination of our ideas.
Thank you world for your participation.

Email: umesh@mec.cuny.edu