

**The use of Requisite Check as an Academic & Curriculum Advisement
Tool in Retaining Underrepresented Engineering Students**

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Abstract

The School of Engineering at the City College of New York in preparing for its forthcoming ABET accreditation visit in 2004, is in the process of implementing a plan which incorporates both quantitative and qualitative approaches. As an urban institution of higher learning, one of the School's missions is to provide education to a highly diverse student body, including traditionally underrepresented minorities, women, working adults, and immigrants in the greater New York metropolitan area. The first objective of implementing a plan to meet ABET 2000 criteria is to gather accurate and reliable information, both in scope and in depth, about the School's present situation and its students' unique needs. One method being used is a manual requisite check by the School's Accreditation Advisors of the College's automated registration system. The manual requisite check was first performed to identify and correct possible errors in an automated registration system but it turned out that performing manual requisite checks during the beginning of each semester for all engineering programs is a powerful tool in the academic and educational advisement of the School. This paper will focus on how this tool is being used to retain students from traditionally underrepresented groups in the School of Engineering at the City College of New York.

I. Introduction

Like most engineering schools across the country, the School of Engineering (SOE) at the City College of New York (CCNY) is engaged in the implementation of a process of continuous improvement in its engineering curriculum. As an urban commuting college, one of the School's missions is to provide education to a highly diverse student body, including traditionally underrepresented minorities, working adults, and immigrants in the metropolitan New York area (the breakdown of undergraduate ethnic groups from Fall 1992-2001 at CCNY was: Black 29.6%, Hispanic 26.0% and Asian 13.5% and for Fall 2001 women represented 20.1% of the college's engineering majors).

A quantitative method, such as a manual requisite check, provides both a means to monitor students' progress through the curriculum and an opportunity to provide proper advisement as a means to insure that students successfully complete the program. This paper reports on the process of a manual requisite check and how it is used in the School of Engineering at the City College of New York to assess and improve curriculum; to strengthen advisement by faculty and academic advisors and; to improve retention of students. By coupling with other techniques, not only have improvements been made to existing curricula but some novelties have been introduced that provide better service for the SOE students. While a full picture regarding the value of such a process cannot yet be completed, it is hoped that this paper will provide readers with ideas that will help them to reap some of the benefits enjoyed thus far by the School of Engineering at CCNY .

II. ABET Preparation

To receive accreditation, The Accreditation Board of Engineering and Technology (ABET) has mandated that each engineering school in the United States develop a plan to satisfy a criterion consisting of eleven (11) student learning outcomes and assessment. The SOE of CCNY's plan in preparing for ABET consists of several main components (as well as, additional parts depending on the program) which are being implemented in a cyclical process for continual program improvement. These components include:

1. *Graduating Senior Surveys*, in which individual students in the senior year (of the respective engineering programs under consideration) are asked to indicate to what extent they believe their respective program has reached the program objectives as defined by ABET;
2. *End-of-Semester Course Surveys*, in which students are asked to indicate to what extent they believe course objectives have been met for the individual courses they are about to complete for the semester. Since the course objectives are linked to the ABET-defined program objectives, the SOE is able to check coverage of a program's objectives through the courses (individually and taken together). Thus, if a

program objective is over represented or underrepresented, the department has a good indication of what action is needed to improve the program;

3. *Alumni and Employer Surveys*, in which engineering departments go outside CCNY for ongoing input from industry (represented by advisory committees) to determine the appropriateness of a program's educational objectives. Each department also has a process in place to ensure direct student input, through student associations, student representation on curriculum committees, student-faculty mixers, etc.;
4. *Pre- and Co-Requisite Checks*, in which all course rosters of a program's core engineering courses are checked to find students that may have registered in courses for which they have not fulfilled the proper requisites. This check is done at the beginning of each semester in order to ensure that students pass through the program in the most effective and efficient way.

This paper concentrates on the pre- and co-requisite checks and its effects on student development and program improvement.

III. Student Information Management System (SIMS)

In the mid to late nineties, CCNY began using the Student Information Management System (SIMS) software. SIMS is a complex integrated information data system capable of performing many functions related to student information, course information and general college administrative information processing. The software is integrated with Interactive Voice Response (IVR) for telephone registration and other information retrieval functions. SIMS can produce transcripts for any student in attendance and provide online information to authorized staff and faculty that is needed to register, advise and graduate a student.

In 2000, SIMS was updated and requisite checking was automated, allowing students to register only for those courses in which they satisfied the required requisites. An attempt to register for a course without the proper pre/co-requisite would result in a rejection by the system. While the system works well most of the time, course registration without the appropriate pre/co-requisites does occur. This glitch in the software causes serious problems for students that register via phone or on-line without the benefit of academic advisement. These students become vulnerable to registering for courses out of the prescribed sequence, which often results in poor academic performance. In an attempt to determine and correct the source of this software system problem, a manual procedure to check pre/co-requisites of engineering courses was developed by the SOE's Office of Undergraduate Affairs.

In performing the manual requisite checks, the following additional limitations of the system were discovered:

1. There is no efficient way to download course rosters from the system. This makes it labor intensive to perform analyses on data for ABET and curriculum improvement purposes. For example, on the student level there is only access to individual student records. At present, the SOE is discussing ways to improve data access with the Registrar's office;
2. The system has a built-in feature to check if students register with the proper requisites and refuses students who do not meet the requisites. However, several things can go wrong using this process:
 - If a student is a transfer student whose transfer credits have not been uploaded to the system. In the past, this could sometimes take several years, especially if a student was not able to provide independent proof of previous education. This is an ongoing problem with students from foreign schools. Unlike the procedure used in the United States, in many countries, a student's records are kept for only a certain amount of time. For example, students who graduated in the Netherlands before 1980, in many instances, would not be able to obtain a transcript of their grades;
 - If the curriculum, including the requisites, has changed. Presently, the system can only handle one set of requisites (generally the most recent) for each course. This means that many students who are still following an 'old' program (i.e. the program they started in when they entered CCNY), cannot register for several courses using the automated system. They must see an advisor who is authorized to override the requisite block;
 - If the requisites have not been installed and/or activated in the system, students who have not satisfied the proper requisites are able to register anyway.

IV. Requisite Check Process

The requisite check is performed by copying the course rosters of engineering courses from the SIMS system into an Excel file after the last day of registration. Each student's transcript is then checked to see if the student has fulfilled the requisites for the courses that are in effect for the curriculum the student is following. If the student appears to be missing a requisite, the student's (hard-copy) file is checked to see if a

waiver for the requisite was issued by the department, or if the student has transfer credits which have not yet been uploaded to the system.

If no documentation is found, the student is notified by a letter and/or phone call and is instructed to see the Dean of Undergraduate Studies or the Department Chair. In order to remain registered for the course in question the student must provide proper documentation and explain the apparent requisite violation to the Dean or the Chair. If proof is not provided, the student is de-registered from the course. All steps are documented in the Excel file.

At CCNY, overseeing the requisite check and sending out letters generally takes each of the SOE's three accreditation advisors and support staff a week. Thereafter, the Dean meets with approximately twenty (20) to forty (40) students for an average of 20 to 30 minutes each. This gives the Dean an opportunity to speak with students about their academic performance and other issues outside of the classroom. This also provides students with an opportunity to receive additional information about other programs at the school and where they can get help if needed. Students are given a waiver for a requisite by their Department Chair for a number of reasons (i.e. transfer student, second degree student, etc.). By doing the requisite check an accurate account of the number of times a requisite course is waived is kept. This information is shared with both the Department Chair and the Department Curriculum Committee of each program as feedback about the Department's curriculum.

For example, if a course is waived an inordinate number of times this is often a good indication that the course is a poor requisite and should be either modified or removed as a requisite. The course CSc 102: Introduction to Computing, which is part of the Civil Engineering curriculum, is a case in point. In Fall 2002, of 58 possible requisite violations, 25 were attributed to students who had not completed this course as a prerequisite for a Civil Engineering course they wanted to take. Many Civil Engineering courses require CSc 102: Introduction to Computing, which forms a bottleneck in the curriculum. The bottleneck can be attributed to the fact that this course, which is taught by the Computer Science Department, has recently been subjected to a very strict policy regarding the granting of transfer credits (e.g., if a student's original "Introduction to Computing" course does not require Calculus I as a prerequisite, which is often the case for an introductory course, the transfer credits are generally not accepted). While this may make sense for transfer students who intend to major in Computer Science, it does not seem to work for transfer students intending to major in Civil Engineering and who come in with most of their Math, Science and Liberal Arts requirements fulfilled. Civil Engineering transfer students could loose up to a semester, because they cannot start the Civil Engineering curriculum without first having to take the CSc 102: Introduction to Computing course.

The Civil Engineering Department is now in the process of analyzing its program and will incorporate the findings from the manual requisite checks on the course CSc 102: Introduction to Computing. Meanwhile, for those students whose progression through the Civil Engineering program would be stalled by the troublesome CSc 102: Introduction

to Computing prerequisite, Calculus I, the Civil Engineering Department often waives this requisite under the condition that it is taken as a co-requisite with the Civil Engineering course under consideration. This demonstrates a clear example of how a manual requisite check can be used in program improvement.

During transfer evaluations, errors can sometimes occur inadvertently accepting transfer credit for courses. The courses accepted in error are, many times, requisites for other courses. When these errors are made there is an opportunity to observe and compare whether there is a difference in the rate of progress through the program of the students with an appropriate requisite versus those students with an inappropriate requisite. In cases where there is no difference between the two groups it can be assumed that the requisite is not a strong one and should be modified or removed.

For example: In the Electrical, Mechanical and Civil Engineering Departments a decision was made to add Vector Analysis to Linear Algebra and to offer a course MATH 392: Linear Algebra and Vector Analysis. It has been observed at CCNY that, in general, transfer students who take Linear Algebra in their previous school do not have the Vector Analysis part. Sometimes students take Vector Analysis as part of another math course or take a Mathematical Methods course. However, students transferring from community colleges generally have not taken Vector Analysis. Until recently, if the latter group had taken Linear Algebra, they nevertheless received transfer credits for the combined MATH 392: Linear Algebra and Vector Analysis course. Thus, beginning Fall 2000, with the introduction of a new CCNY course equivalencies guide, this important change disallowing transfer credit for MATH 392 from the community colleges has been made. Of course, there remain those students that received transfer credits for MATH 392 as a result of evaluators using the 'old' guide instead of the new one or working from memory. A preliminary study into the effects of students (who had not taken the appropriate MATH 392: Linear Algebra and Vector Analysis course) on study success in courses that require MATH 392 indicates there may be no significant differences between the students who took the 'appropriate' course versus the students who did not. Results must still be consolidated, yet if the indications turn out to be correct, the Mechanical and Civil Engineering Departments would have to reconsider the place of the Vector Analysis requirement in the curriculum. Although Vector Analysis is a perfectly appropriate requirement in an undergraduate Engineering curriculum, it may be impractical to combine it with Linear Algebra from the perspective of an efficient transfer process. However, the previous solution, granting all students transfer credits for MATH 392, even if they had not done Vector Analysis, would still need to be addressed as it could still result in potential problems, for example, if an engineering student decides to switch from Mechanical or Civil to Electrical Engineering, a program in which there is a vital need for a student to have thoroughly covered Vector Analysis for several subsequent courses in the Electrical Engineering curriculum.

A third important outcome of the requisite check is the decreasing percentage of students whose transcript shows insufficient requisites for one or more of the courses

they registered for. In order to avoid problems, students who want to register for courses, see an advisor first in increasing numbers, to make sure they have the proper requisites. Until recently, many just tried to 'get away' with lacking requisites if the system did not catch them and had to suffer the consequences in terms of poor academic performance. If a student's transfer credits are not uploaded in SIMS, action is undertaken to ensure his or her transcript is evaluated expediently. In Figure 1, the black squares indicate the total percentage of registrations in all courses of the respective program appearing to violate requisite(s) e.g., a student who was registered for CSc 102: Introduction for Computer

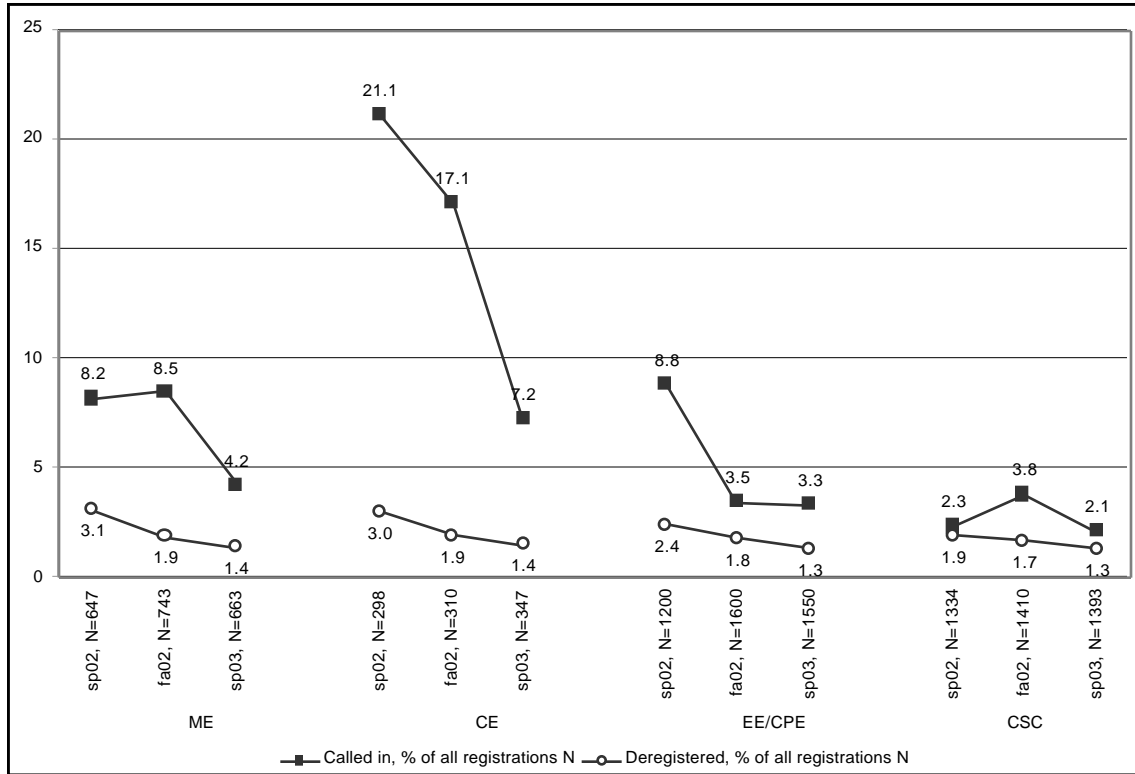


Figure 1. Requisite checks in three (3) semesters for the Mechanical, Civil, Electrical/Computer Engineering programs and the Computer Science program at CCNY.

Science who did not appear to have fulfilled the required prerequisite, MATH 201: Calculus I. The white circles indicate the total percentage of those registrations deregistered from the total number of registrations in all courses of the respective program. The symbol N in Figure 1 concerns numbers and percentages of registrations, not students, since a student generally registers for more than one course and could also be de-registered for more than one course. Civil Engineering had a relatively high number of apparent violations in Spring 2002, because there had been extensive changes in the curriculum in prior years, including the requisites. In many cases this made it difficult to determine exactly what curriculum the students were in, and the requisite check turned out to be a good instrument in clarifying matters for students, as well as, the Department. In Spring 2003 the percentage of apparent violations decreased drastically.

As Figure 1 shows, the percentage of actual de-registrations appears to be approximately the same from department to department for a given semester and appears to decline overall for the respective Departments with each successive semester. This would infer that the Departments have a consistent policy on decisions regarding student deregistration. The declining percentage of apparent violations (black squares) would indicate that the documentation in the student's file and in the student registration system regarding Departmental approval of exceptions from prerequisites and transfer credits has improved so students do not need to provide information each semester to their respective Departments or the SOE.

V. Conclusion

In order to do proper advising, which is a powerful tool used in the retention of students, it is first necessary to get students to see an advisor. Therefore, although the manual procedure to check pre/co-requisites of engineering courses was implemented primarily in an effort to correct technical problems related to the SIMS automated requisite check, it has become a very effective way to persuade students to get the advisement they need. It turned out that the semesterly requisite checks could also be used effectively to detect and remedy curriculum problems for both continuing and transfer students. This procedure falls very much in line with ABET's theme of ongoing evaluation and the use of the results to improve the effectiveness of a program.

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Annita Alting has a Masters degree in physics from Groningen University in The Netherlands and a PhD in physics education from Eindhoven University of Technology. She taught physics and mathematics in Dutch secondary and higher education, and worked as an educational researcher and academic advisor in the areas of science and engineering. After her arrival in the United States, she was a research associate in IBM Research in Hawthorne, NY, for three years. Since 2001 she works as ABET accreditation specialist in the School of Engineering of the City College of New York.

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