

**AC 2000-247: Framework for Instructional Modules for the MSIP Project "Working in Teams to Enhance Pre-Engineering Curriculum"**

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## **Framework for Instructional Modules for the MSIP “Working in Teams to Enhance Pre-Engineering Curriculum Project” or WITEPEC Project**

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### Abstract

The goals of the Minority in Science Program Project, “Working in Teams to Enhance Pre-Engineering Curriculum” are encompassed in the overall objective of increasing the success of minority students in gatekeeper engineering and science courses. The mechanisms proposed to obtain this goal include the development of a number of instructional modules for pre-engineering and science courses that will specifically address many of the barriers encountered by minority students in these courses.

A number of instructional modules are being developed for each of the following college level courses, that have been identified as gatekeeper courses for minority students: Calculus, pre-Calculus I, Physics, Chemistry, and four of the introductory engineering courses, Statics, Dynamics, Engineering Graphics, and Introduction to Engineering. Most of these courses are offered in community colleges that have pre-engineering and/or pre-engineering technology programs and serve a large number of minority students.

This paper presents the conceptual design of the module format and the rationale behind this design. There are several unique aspects to the conceptual design of the modules that will be presented and explored in detail in this paper and presentation. Finally, examples from some of our first modules will be shared.

### Introduction

The development of the skill set and background knowledge required to complete an ABET engineering degree is a demanding activity for most students. This is a particularly true statement for students that enter a pre-engineering program of study with some deficiencies in their high school educational experience. Such students find the pace and expectations of the engineering oriented science and mathematics courses difficult to maintain. These same students may also encounter difficulties in remedial courses designed to facilitate students that encounter this situation. Minority students are often caught in this almost impossible catch up situation. This is specifically the case with minorities for whom English is their second language.

One approach to helping students avoid this descending cyclic path is being developed by educators under the guidelines set forth by the US Department of Education Minority in Science Program, MISP. This effort is focused on students whose first language is Spanish. Teams of educators primarily from two-year institutions which are members of the National Hispanic Bilingual Engineering Program (NHBEP) Consortium are creating a set of modules that address

educational barriers that many minority students face in pre-engineering courses of science, general engineering and mathematics. The project will produce modules that serve as supplemental learning materials in a self-study but faculty guided mode to lower the learning barriers that these at-risk students often encounter.

The importance of the instructor as a mentor and facilitator for a minority student is not to be under valued. These MISIP will modules focus the student’s attention on the specific concepts or knowledge that is their current challenge. However, the student’s success with these concepts will depend on the interest and involvement of the course instructor. These modules are not intended to be a completely self-help vehicle with students off on their own trying to remedy a significant knowledge base situation any more than tomorrow’s engineer will be expected to single handedly solve a serious engineering problem. Then, as now, teamwork is the mode of operation.

### Module Superstructure

Figure 1 illustrates the superstructure format for modules associated with this project. The graphic is currently being used as a structural guideline by faculty teams as they develop modular materials. Each module will have components or sections that are identified as motivation, goal, objectives, content, practical applications, practice, related learning use of technology and self evaluation. This structure was developed as a result of a series of intensive workshop secessions in which the educators from the Hispanic minority institutions carefully considered the various factors that impact students in their math, science and pre-engineering classes. Each component of the superstructure is discussed in turn below.

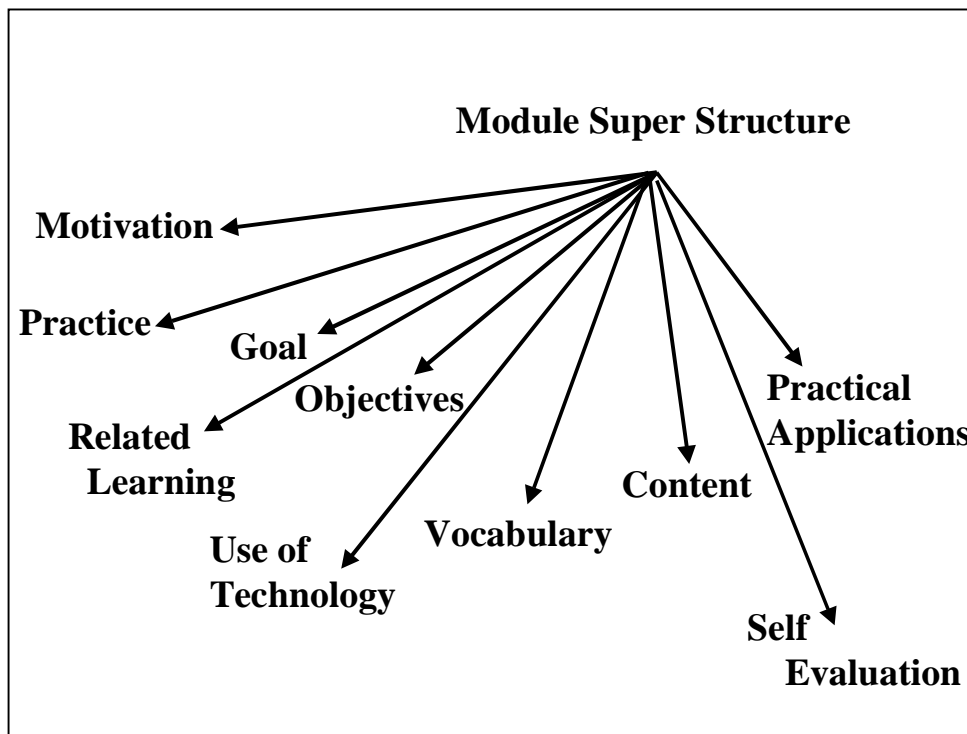


Figure 1. Superstructure of the MISIP Modules.

Like traditional educational modules, the goal and objective statements are very important. However, for these modules, the intent of these two categories is to make both the content and the context clear and concise. Additionally, the perspective of the motivation message reflects the students' need to know two things. First, the immediate knowledge of how this module will help them survive what they perceive to be a difficult learning situation. Second, the long-term assurance of how the module's activities have practical value for their engineering careers.

The vocabulary component of the module is one of several enrichment module elements that exist specifically for the minority students. It is certainly the intent of each module to provide concrete assistance to all students that may find the subject matter of a module difficult. Difficult concepts are difficult for the general student population. The minority student is not special because they have problems with difficult concepts. However, there is often an extra burden that language can add to an already difficult topic. Thus the vocabulary element in each module will certainly include a summary of important vocabulary terms, and/or symbols used in the module. This glossary type information will be immediately available so that vocabulary reinforcement is a low energy activity for the student. However, the module's vocabulary element will stretch the typical limits of a vocabulary list. The vocabulary element for each module will include mental image building phrases. This prose will assist students who need to bridge the gap between the English technical terms and a comfortable working image for a perhaps totally unfamiliar use of the English term. The objective here is to make sure that students who would tend to literally translate English will have assistance if needed in the assimilation of the not-so-literal aspects of a technical term or definition.

The content portion of a module presents the lesson of the module. Students will find the details of the material they require assistance in within this component of the module. The knowledge that the students are to learn will be presented in the format and medium that best transmits the ideas of interest. Again language and mental images are recognized as important elements of the learning process. Animations, streaming videos and other multimedia learning tools, will be used as appropriate.

The content component of a module will always include knowledge, web link and practice examples and problems sections. It is anticipated that all of the modules developed within this initiative will involve concepts that require repetition and recitation to assure mastery. It is also expected that all of the module content components will include a content sub-component for instructors. Naturally, the intent here is not to teach the instructor the module content but to focus the instructor's attention on the aspect of the knowledge that might be particularly troublesome for the minority student.

The practical applications component of the module is a direct attempt to tune the student to the engineering aspects of the module's lesson. The task of this module component is to assure the student that the material to be mastered will be used. In some cases the new skills could be used in immediate every day life but in all cases these new student attributes will be used in future engineering courses. Actual engineering "on the job" activities involving this new knowledge will be introduced at this point.

The practice component of the module will simply demonstrate that necessary fact related to learning pre-engineering and/or engineering topics. Practice is a required element of this learning process for most if not all students. Practice is particularly pertinent for minority students. If a minority student is faced with difficulty with a concept, it is anticipated that a significant reason for this situation is the student's lack of exposure to the preliminary structure associated with this knowledge. At this point in their student careers, extensive practice will expedite their learning process.

Although the practice component will involve repetitive exercises, it is not simply a student workbook type of learning experience. The unique characteristic of this component of the module is that students will be encouraged (required) to work with other students on different parts of some problems. Some activities will be structured such that the students will need to work together, share both solution techniques and/or parts of a problem solution to develop a final answer. These activities should enhance the students teaming skills as well as enrich and expand their understanding of the context and content of the language.

The related learning component of the module will provide an awareness of the impact that the module's knowledge base has on the world's historical, cultural, social and/or ethical development. The intent of this component is to help put the figures and formulas of mathematics, science and engineering in a broader, more meaningful context that includes emphasis on language. It goes without saying that it is easier to learn and comprehend new material when it is associated with something that has meaning to the students. Although this appears to put an extra time burden on both students and faculty, the long-term result is that the student not only learns the skill better but also understands why it is important to his engineering studies and why it will be important to his engineering career. Additionally, the related learning information in the modules will further reinforce the underlying language theme of these modules.

The Use of Technology component of the MISP modules for pre-engineering courses will contain some straight-forward tools to aid the learning tasks. Such tools might include the basics of specific software or calculator routines for particular problem types that have been encountered in the module. The emphasis here will be alerting students who may be unfamiliar with available and useful tools about their existence as well as lowering the barrier to the use of the new tool by providing simple verbal and graphic instructions for its use.

The final component of each module will be a self-evaluation. The intent of this module is to allow the student to privately assess his competency of the skills learned in the module. One goal for the self-evaluation exercises of these modules will be to reinforce the typical English presentation of the concepts and problem statements without being threatening to the minority student. Worked out solutions will be provided with commentary when necessary.

## Summary

It is anticipated that the ever-increasing high technology and engineering workforce of the twenty-first century will need to include a much larger number of minorities than currently exists. It is also well known that young minority students are often not as well prepared for the

rigors of engineering education as their non-minority counterparts. The reasons are many and varied and have been, and will continue to be hot topics for discussion and debate in many public and private educational, cultural, and social agencies. The reasons, of course, vary from student to student and also from year to year and course to course. However, there are some common threads. From a broad perspective, one of the problems is difficulty with language, and language in the fullest context of the word. One of the primary objectives of these educational modules is to lower the language barrier in a non-threatening manner by immersing the student, who may not be comfortable with a particular mathematical or technical concept, in a sea of images, vocabulary, contextually set problems, related learning, and practical applications. It is expected that both real and perceived barriers to learning can be lowered by this approach thereby providing a more comfortable environment for the tasks of “learning”, and in turn, more success.

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