

## Making Sense of Those Early Required Courses

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Engineering experiences that freshmen and sophomores face in their initial contacts with the university are very similar. Students enroll in physics, math, chemistry, humanities, composition, and social studies. Those subjects seen from the students' perspective appear to be ends in themselves with little importance to future classes in the majors. If, in any, connections are drawn between these lower tier courses (freshman/sophomore) and the upper level courses (junior/senior.) The general university curriculum requires that this broad range of courses should be completed before a student reaches the junior and senior years, providing a foundation for the work in the major subject. Problems can arise, though, when students enter classes where no attempt is made to draw distinct connections between what is being done in those early courses and the courses that will come in the major field. Students become concerned when they are told that they are to simply learn the material because it is "good for them" or that is "to be learned for its own sake."

Vast numbers of students move through the university system accomplishing all that is asked of them, graduating with seeming relative ease; but when discussion takes place, one discovers that there are underlying difficulties in the system. Students are quick to comment off the record concerning the difficulty of taking courses that fail to draw connections to either the real world or future courses in their majors. They find them baffling in many respects until someone makes the effort to draw logical connections between those initial courses in the academic system and the later major driven classes.

This paper presents a look at materials collected for lower-tier students by upper-tier students who were interested in providing concrete rationale for the taking of the required lower-level courses. The culmination of the work will be brochures that can be provided to all students interested in engineering concerning the connections between lower-level course and upper-level courses in the major.

### Introduction

Perhaps one of the most difficult experiences that freshmen and sophomores face in their initial contacts with the university is the issue of connectedness of lower tier courses (freshman/sophomore) with upper level courses (junior/senior.) The general university curriculum requires a broad range of courses that should be completed before a student reaches the junior and senior years. These courses include humanities; composition; social studies; and a complete set of math, physics, and chemistry courses. Problems can arise when students enter

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classes where no attempt is made to draw distinct connections between what is being done in those early courses and the courses that will come in the major field. Students become concerned when they are told that they are to simply learn the material because it is “good for them” or that is “to be learned for its own sake.”

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The current work in progress involves that body of students who feel that they have an interest in engineering as a career choice. The targeted sub group consists of any students who have qualms over what they are being required to learn in courses like mathematics, chemistry, physics, or language arts. The projected initial numbers of students impacted could be as many as 3,000 students with as many as 1,500 added to the group each year. Faculty members and students are being surveyed concerning the items to be placed in the brochures and on the web that will help provide needed connections between courses required in the lower levels and courses in the majors at the upper levels.

The above foci are addressed within the proposal by providing students with a means to look closely at the connections between their current courses and those courses that will be required of their majors through quick reference materials (brochures) and more detailed materials (website content.) Engineering careers require mathematics, chemistry, physics, and language skills. This project aims to give students the means to explain why their lower tier courses have importance in their careers. When given the connective quality, students are quick to voice positive remarks, “I enjoyed the integration of subjects because I enjoy seeing the big picture. I really need to see the big picture to understand things.”

Probably the most important aspect of the project is retention. Students who have all the necessary tools to become engineers may fall away from engineering simply because they see no relation between what they seem to be forced to take in the lower tier and required (interesting and valuable) courses in the upper tier. Hopefully by providing these connections, students will be more apt to continue within the engineering area. The Foundation Coalition has stated, “Curriculum integration implies restructuring learning activities to help students build connections between topics. A seminal study by Seymour and Hewitt concludes that one of the reasons students leave science and engineering is that they lose interest. Building connections and establishing greater relevance is important.”

Since it appears that little is being done to acquaint students with the actual importance of these early courses with their future work, one would feel that any effort to provide connections would improve the current status of career development services. Many students enter Michigan State University with engineering in general or a specific engineering program in mind. They come enthusiastically searching for that career of the future. Some of these are really on the wrong

track, and they will change their directions and hopefully graduate with one of the many other degrees on campus. A certain percentage will forge ahead and successfully complete the engineering degree requirements. But another group of students will fail to see any connections between their early courses and the engineering that they picture in their minds. They will fall away from the engineering areas because little or no effort is made to explain why courses in the freshman and sophomore years have any importance in the courses that they take in the degree programs started in the junior year. This beginning provides students with practical information on the use of their lower-tier courses. Western Carolina University also sees the importance of drawing connections through the “implementation of Learning Communities that will help students bridge intellectual domains and find community and the implementation of a Freshman Seminar that will help students establish a connection to the University and an appreciation of the education experience.”

Students making critical decisions in their career paths will be able to understand the need for the beginning courses pertinent to engineering when they understand how each of these courses contributes to the necessary foundation for their upper-tier courses. The lower tier courses that seem to have the most disconnectedness to upper tier courses are:

- American Thought and Language (the traditional English composition course)
- Humanities
- Interdisciplinary Social Studies
- Mathematics
- Chemistry
- Physics
- Statics
- Thermo-fluids

The current courses being studied for connections to the above are:

- ME 332 - Fluids
- ME 412 - Heat Transfer
- ME 451 - Controls
- ME 461 - Vibrations
- ME 371 - Design I
- ME 471 - Design II
- ME 481 - Capstone Design

The project requires that eventually all units within the College of Engineering be a part of the data collection. Each department is being surveyed to gain information on practical uses for the lower tier courses. Hopefully, this will provide departments with a central depository in which to add continuing information for the students' benefit.

Currently upper-tier students are brainstorming personal impressions they have had with their own connections between lower-tier and upper-tier courses. Faculty are also being asked for examples and problems that will show the importance of learning the lower-tier materials.

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Some of these collected connections include:

- Statics – Newton’s fundamental laws for forces
- Dynamics - Newton’s fundamental laws for forces
- Heat Transfer – Analysis of heat transfer phenomena
- Mechanical Design – Newton’s Laws
- Control Systems – Newton’s Laws of Motion
- Thermodynamics – Power cycle, relationship between properties of fluid
- Matlab
  - a. The solving and graphing of circuits that contain equations with many unknowns
  - b. The solving of differential equations, root loci, and bode plots
  - c. Graphing functions
  - d. Solving matrices and complex equations

Presenting these and much more detailed connections to the lower tier students will hopefully encourage these students to continue in their programs with a belief that what they are required to take in those early academic years is valuable for upper level study. Surveys have been prepared and distributed to graduating seniors to capture their insights into the relationships of lower tier courses to courses in their major.

#### Continuing Work

Replication will be a relatively easy process. Other units will be able to see how the lower tier courses that are required within their programs can be connected to upper tier courses. The surveys given to students will be available on the web, along with all the anecdotal material and specific detailing of the connections between lower tier courses and upper tier courses in engineering.

Here the faculty and students can draw the same connecting lines between both lower and upper tier courses for high school students who may be contemplating engineering as their career path. As the importance of reaching into the high schools and middle schools to foster interest in engineering to younger and younger students becomes apparent, faculty who visit K-12 classrooms and college students who return to their home schools can talk not only about the excitement of engineering but the need to build upon a sound foundation in order to succeed as an engineer. This discussion can focus on the ways in which the courses taken in both high school and the early years of college will prepare students for courses specific to their majors. This pre-knowledge of connections will hopefully help students understand that importance before they take the courses and not after they graduate.

#### Final Thoughts

With a new generation of students who have access to massive amounts of data, we are seeing the need to present tangible connections between activities that we feel are basic for learning and the more focused activities that students feel are important to them. When these two bodies of information do not contain visible bridges we must make the connections clear. It is important that we carefully explain to students the value and use of these early courses to their later courses

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and careers. It is then the responsibility of every instructor to foster discussion on the varied uses of all that is taught.

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