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Introducing Research into Undergraduate Honors Program

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Abstract

Most colleges and universities have some sort of system in place for recognizing the accomplishments of highly qualified and motivated students who have achieved academic excellence. One example of such a system is an established honors program. The honors program at Ohio Northern University strives to stimulate highly qualified students in any field of study who are capable of meeting academic challenges and who choose to do so. Students are encouraged to develop their full intellectual potential within a continuing community of scholarly excellence that offers exciting and enhanced varieties of academic experiences. Honors program experiences are designed to nurture students' curiosity, their written and oral communication skills and their leadership capabilities as well as to provide an opportunity for students to be more actively involved in their education.

Each honors student is required to complete a series of honors seminars, "contract" courses and a final honors project. The project is a major research, performance or creative endeavor guided by a full-time faculty member. Two existing courses at the junior-level or higher must be completed with contracts. The contracts do not provide more credit hours for a course, but rather agreement on the part of the student to complete work in greater depth. The student initiates contract proposals with guidance from the instructor, and the honors program committee places a copy of the final contract on file for review. The course instructor certifies completion of the contract at the time of reporting final grades.

Research projects are an excellent means of satisfying the objectives of the honors program. This is corroborated by student assessment and evaluation at the end of the contract course. An example of such a project is described in this paper. The first two authors supervised two students in a research project at Ohio Northern University during their contract course in transportation engineering in the 2003-04 academic year. The project involved fundamental research into pavement-tire interface behavior. The students studied the effect of temperature on the adhesion and hysteresis components of tire-pavement interface friction. The scope of the work involved designing experiments, performing experiments, literature review, data reduction and analysis, technical writing, and interaction with outside engineering professionals.

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Introduction

The academic community has recognized the benefits of undergraduate student participation in research. Participation in research helps students attain a higher level of competence in science, mathematics, engineering and technology; understand the methods and process of research; make informed judgments about technical matters; and communicate and work in teams to solve complex problems[1]. Other frequently voiced outcomes include the ability to think independently and an increase in originality, creativity and curiousity[2]. Zydney et al.[3] performed a survey of alumni who had experienced undergraduate research at the University of Delaware. Alumni with research experience were more likely to pursue graduate degrees, and they reported greater enhancement of their ability to carry out research, speak effectively, understand scientific findings, know literature of merit in the field, analyze literature critically, and possess clear career goals than did alumni with no research experience.

There have also been reports that suggest that there is a need for incorporating a wider population of undergraduate students in research. A 1998 workshop by the National Research Council[4] stated that "research is a necessary component of the bachelor's degree education". The National Science Foundation has presented undergraduate research as a critical component of its core strategy for education reform[5]. The undergraduate research experience is suggested as an effective educational tool for enhancing the undergraduate educational experience and achieving educational goals[6].

Undergraduate students play a critical role in the conduct of research at predominantly undergraduate institutions. The National Science Foundation recognizes the important role that these institutions play in U.S. science and technology[7] and states that "as the ultimate in inquiry-based learning, undergraduate research is a critical component of high-quality education. A significant fraction of science, mathematics, engineering and technology professionals receive bachelor's degrees from predominantly undergraduate institutions."

There are several avenues available for undergraduate students who wish to pursue research. These include courses resulting in academic credit and university supported programs that may provide a stipend. The National Science Foundation has an established Research Experience for Undergraduates (REU) program where students can conduct research at one of many participating sites across the nation during summer while receiving a stipend.

The Honors Program at Ohio Northern University

The honors program experience at Ohio Northern University (ONU) is designed to nurture students' curiosity, their written and oral communication skills, and leadership capabilities as well as to provide an opportunity for students to be more actively involved in their education. This program consists of first-year honors seminar and three additional honors seminars adding up to16 credit hours; two contract courses at the junior-level or above; and a final honors project approved by the department of the student's major. The Civil Engineering Department at ONU

permits the honors seminar and honors project courses to be used in partial fulfillment of general education requirements.

Two existing courses must be completed with contracts. Contracts do not provide more credit hours for a course, but rather agreement on the part of the student to complete work in greater depth. The student initiates contract proposals with guidance from the instructor. The honors project is a major research, performance, or creative endeavor, guided by a full-time faculty member. Each student must give an announced, public presentation of the completed honors project. In the fall quarter of academic year 2003-2004, authors Middelberg and Stiles approached the faculty members (the co-authors) about a contract course in the area of transportation engineering as a part of the CE 351 Transportation 1 course.

Synopsis of Research Project

The area of research in this project was the skid resistance of asphalt pavements. Skid resistance may be defined as the steady-state friction forces acting on a locked test wheel as it is dragged over a wetted pavement surface under constant load and at a constant speed. It is widely accepted that the two components of skid resistance are adhesion and hysteresis. The adhesion component is the product of the actual contact area between tire and traveled surface and the interface shear strength. The adhesion component is normally attributed to the molecular bonds between the tire and the contact area in the pavement surface. The strength of those bonds is dependent on the natural affinity between the materials. The breaking of those bonds requires some energy. This energy is the work done by the adhesion forces. The hysteresis component is observed when pavement surface asperities produce appreciable deformation of the rubber tire. It reflects the energy losses that occur as the rubber is alternately compressed and expanded as it slides over the irregular pavement surface texture. Deformation of the rubber will occur, and hence the hysteresis component will exist, even if the pavement surface is perfectly lubricated.

In the United States, the most common method of performing skid tests is by means of a vehicle pulling a two-wheel trailer whose wheels have been locked in place. The friction force is recorded and a skid number is calculated and assigned to the pavement section. Skid numbers are normally used by highway agencies to identify pavement sections with low skid resistance, to develop priorities for rehabilitation, and to evaluate the effectiveness of various pavement mixtures and surface types. Another device widely used to assess the skid resistance of road surfaces is the portable British Pendulum Tester. A pad of tire-tread rubber mounted at the end of the pendulum arm slides over the road surface on which the tester is placed. The difference in height of the center of gravity of the slider head between the horizontal release position and the highest point of the swing after the slider has passed over the road is used to calculate the loss of energy arising from friction.

No previous research project was able to conclusively demonstrate the dependence of skid resistance on temperature. The experimental setup in this research project was aimed at separating the two components of friction and conducting measurements of both components at different temperatures. The British Pendulum Tester was used in a laboratory setup to measure the two components of friction on test briquettes. To simulate the polishing of pavement surfaces

as a result of repeated application of wheel passes; the briquettes were subjected to cycles of mechanical polishing using aluminum grit and a drill press equipped with a rubber-polishing disc.

Briquettes representing ten asphalt pavements in the State of Ohio were used in this research project. Five of the sites were constructed with gravel aggregate and the other five were constructed with limestone aggregate. The hysteresis and adhesion friction measurements were performed on each briquette at five different temperatures and four different cycles of polishing. This experimental setup produced a substantial amount of data.

The students started by familiarizing themselves with the research topic. The topic was not a subject that had been covered in any of their completed courses. A literature review in engineering and technical databases was conducted at the university library. A collection of relevant publications and references were identified and later reviewed by the students. The students were also introduced to pertinent technical aspects of the research project by the faculty researchers to provide them with a better understanding of the subject area. Once the students had obtained the necessary background knowledge in the research area, they were able to better appreciate the objectives of the research and realize the desired outcomes of the project. In addition, the students attended two professional meetings in the area of pavement management to understand the significance of skid resistance observations in the decision-making process of pavement maintenance. The students also performed test measurements using the British Pendulum Tester according to applicable ASTM standards.

Through the use of Microsoft Excel spreadsheet, the students managed the collected data, and performed the necessary summary statistics and the corresponding graphical representations. This required the students to think critically in identifying trends in the data. It was left to the students to rationalize the results and obtain correlations between the studied variables. The students were asked to summarize their findings and present them to the faculty researchers in the form of periodic progress reports. The students were left to perform the analysis independently to allow them the benefit of deducing trends in the data. They were also given the opportunity to defend their interpretations of the results using scientific reasoning. The students were also required to write a final technical report and given the opportunity to co-author a conference publication. This allowed the students to improve their oral and technical communication skills.

Conclusions

Completing this project afforded Middelberg and Stiles the opportunity to learn about research in the field of engineering. They encountered the elements of literature review, professional correspondence, and data reduction and analysis. In addition, they were exposed to a highly technical and advanced area of transportation engineering. The contract course allowed the students to explore an area of study that they might not otherwise get to experience. When asked about their impressions of the contract course, Stiles and Middelberg offered these comments: "I found the contract course to be very rewarding personally and academically. Having the opportunity to do research with my professors was fantastic, and I learned an amazing amount of

knowledge about skid resistance. Although the subject may have been advanced and we may not have grasped it totally, I found the research experience to be invaluable," Stiles explains. Middelberg agrees, "I really enjoyed this contract course experience. I appreciated the opportunity to work together with faculty members on an exciting research project. Without the honors program, this type of research might not have been offered to us until graduate school."

This was the first experience for the faculty to deal with honors students in a contract course. Both faculty members found the experience to be positive and rewarding. The students were highly motivated and were able to conduct productive research with minimal time demands on the faculty. The project also seemed to provide an excellent forum for enhancing the educational experience and producing the desired outcomes for undergraduate engineering students.

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