

## **New Introduction to Infrastructure Course at Rowan University**

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### **Abstract**

Rowan University began offering a new two-credit course called Introduction to Infrastructure in Spring 2015. This course is required for all freshmen in the Department of Civil and Environmental Engineering at Rowan. The course was developed as part of a collaborative project funded by the National Science Foundation's Transforming Undergraduate Education in Science, Technology, Engineering, and Mathematics (NSF-TUES) Program. The collaborative group of colleges and universities involved in this NSF-TUES project is led by the University of Wisconsin-Platteville and is called the Center for Infrastructure Transformation and Education (CIT-E). The topics covered in the course include an introduction to infrastructure, public financing and economics, social impacts of infrastructure, water resources engineering, environmental engineering, geotechnical engineering, structural engineering, and transportation engineering.

### **Keywords**

Freshmen, Engineering, Infrastructure

### **Introduction**

Rowan University began offering a new two-credit course called Introduction to Infrastructure (I2I) in Spring 2015. This course is required for all freshmen in the Department of Civil and Environmental Engineering (CEE) at Rowan. The course was developed as part of a collaborative project funded by the National Science Foundation's Transforming Undergraduate Education in Science, Technology, Engineering, and Mathematics (NSF-TUES) Program. The collaborative group of colleges and universities involved in this NSF-TUES project is led by the University of Wisconsin-Platteville (UW-P) and is called the Center for Infrastructure Transformation and Education (CIT-E)<sup>1</sup>.

The topics covered in the course include an introduction to infrastructure, public financing and economics, social impacts of infrastructure, water resources engineering, environmental engineering, geotechnical engineering, structural engineering, and transportation engineering. The course also includes guest lectures by other CEE faculty. A total of 64 students were enrolled in two sections of the course during Spring 2015. The course was assessed using student pre- and post-surveys. The results of these surveys are presented below. In addition to these pre- and post-surveys, new online student surveys developed by CIT-E were implemented beginning in Spring 2016.

The initial theme of the I2I course at Rowan was the impact of major storms on infrastructure<sup>2,3</sup>. We discussed the impacts of Superstorm Sandy on water and wastewater treatment plants in New Jersey, and the impacts of Hurricane Katrina on levees in New Orleans and on bridges in Louisiana, Mississippi, and Alabama<sup>4-8</sup>. These impacts include interruption of access to energy, clean water, and the ability to travel safely in the affected areas. Students considered how these services are interconnected, and the repercussions when access to them is no longer available. In addition, they investigated the social, economic, and political consequences when local infrastructure is no longer properly functioning. Students were required to write a team term paper on the failure of one levee or one bridge during Hurricane Katrina.

The areas covered in the following sections of the paper include a course overview, the assessment of the course, the impact of the course on student retention from the freshmen to sophomore years, and the original and revised themes for the course.

### **Course Overview**

The new Introduction to Infrastructure (I2I) course was taught for the first time at Rowan University in Spring 2015. The course is now a permanent part of the freshmen curriculum in the Department of Civil and Environmental Engineering (CEE) at Rowan. The course was team taught for the first time by Dr. Joseph Daraio and Dr. Ralph Dusseau. The original theme of the course was the impact of major storms on infrastructure. Dr. Daraio used lectures from UW-P and the United States Military Academy at West Point to cover the introduction to infrastructure, public financing and economics, and social impacts of infrastructure, and the areas of water resources engineering and environmental engineering. In particular, Dr. Daraio included the impact of Superstorm Sandy on the water and wastewater treatment plants in New Jersey. Dr. Dusseau used lectures from UW-P and his own lectures on Hurricane Katrina to cover the areas of geotechnical engineering, structural engineering, and transportation engineering. In particular, Dr. Dusseau discussed the impact of Hurricane Katrina on the Gulf Coast states. Student teams prepared term reports on the failure of one bridge or one levee as a result of Hurricane Katrina.

The I2I course was taught for the second time in Spring 2016. Enrollment was 74 students divided into two sections of 38 and 36 students. The course was team-taught by Dr. Dusseau and Dr. Jenahvive Morgan. Dr. Morgan was responsible for the introductory lectures and the lectures on water resources engineering and environmental engineering. Dr. Dusseau continued to teach the lectures on geotechnical engineering, structural engineering, and transportation engineering. Dr. Dusseau and Dr. Morgan changed the theme of the course as discussed below. The pre- and post-surveys were again implemented. In addition, the new online survey prepared by CIT-E was also implemented.

### **Assessment of the Course**

The key outcomes that are specific to Rowan University were the pre- and post-surveys that were conducted for the first and second years in the new Introduction to Infrastructure course at

Rowan University. The questions for both the pre- and post-surveys were the same. Many of the questions used for these surveys were based on a similar on-campus survey used at UW-P. In order to meet IRB requirements at Rowan University, the anonymity of the students had to be maintained throughout the survey process. Thus, the students were assigned random numbers on their syllabi and they proceeded to use these random numbers for both their pre- and post-surveys. This enabled direct comparisons between each student's pre- and post-survey responses. Four of the quantitative questions (1, 2, 9, and 10) that were included in the surveys will be discussed here:

Question 1 – Which is the most appropriate definition of “sustainability” as used by engineers?

For this question, the correct answer is “b”. For 2016, the number of students who chose “b” increased slightly from the pre-survey to the post-survey: 45.8% of students got Question 1 correct before the class began and 46.3% got the question correct after the class ended. As a comparison, the pre-survey and post-survey percentages for Spring 2015 were 42% and 75%, respectively. This indicates that more emphasis was placed on sustainability during Spring 2015 versus Spring 2016. As a result of these Spring 2015 and Spring 2016 survey results, more emphasis will again be placed on sustainability for the third offering of the Introduction to Infrastructure course in Spring 2017.

Question 2 – If you were to characterize the state of the nation's infrastructure (roads, bridges, sewers, water supply, etc.) using a typical grade scale, what grades do you think would be most appropriate?

For this question, the correct answer is “c”. For 2016, the number of students who chose “c” significantly increased from the pre-survey to the post-survey: 29.2% of students got Question 2 correct before the class began and 89.6% got the question correct after the class ended. This is very similar to the pre-survey and post-survey percentages for Spring 2015 which were 39% and 89%, respectively. Thus, the emphasis placed on grading the nation's infrastructure for the Spring 2015 and Spring 2016 offerings of the course will be continued for the third offering of the Introduction to Infrastructure course in Spring 2017.

Question 9 – Which area of civil engineering are you most interested in working in?

For this question, the answers were a) environmental engineering, b) water resources engineering, c) geotechnical engineering, d) structural engineering, e) transportation engineering, and f) other (explain). For 2016, the before and after percentages were a) 16.7% versus 19.7%, b) 11.9% versus 5.3%, c) 3.6% versus 10.5%, d) 47.6% versus 43.4%, e) 14.3% versus 17.1%, and f) 6.0% versus 3.9%, respectively. Thus, for Spring 2016, there was some movement away from water resources engineering, structural engineering, and other and some movement toward environmental engineering, geotechnical engineering, and transportation engineering. As a comparison, for Spring 2015, there was some movement away from environmental engineering and structural engineering and some movement

toward geotechnical engineering, transportation engineering, and other with no change in water resources engineering. We assume that the changes in student preferences both years were a result of student knowledge gained during the course, especially in areas, such as geotechnical engineering and transportation engineering, that students may not have known as well before the course began.

Question 10 – What is your current level of interest in pursuing a career in civil engineering?

For this question, the answers included a) very high, b) high, c) moderate, d) low, and e) very low. For 2016, the before and after responses were a) 43.1% versus 52.2%, b) 43.1% versus 35.8%, c) 13.9% versus 7.5%, d) 0.0% versus 3.0%, and e) 0% versus 1.5%. Of the 61 students who registered both before and after survey responses to this question, the number of students whose interest in civil engineering increased during the semester was 14, the number of students whose interest decreased was 6, while the number of students whose interest remained the same was 41. Thus, there was a slight increase in the student level of interest in civil engineering as a career for Spring 2016, which is very similar to the results obtained for Spring 2015.

For Spring 2016, in addition to the in-class surveys discussed above, online pre- and post-surveys were also conducted by Carol Haden of Magnolia Consultants, Inc. as part of the CIT-E collaboration. The before and after versions of these online surveys are the same. The results of these surveys have not yet been collated.

### **Impact on Student Retention**

One of the original goals of the I2I course was to increase student retention in CEE from the freshmen to sophomore years. During the year (2014) before the I2I course was implemented, the number of CEE students who moved on from the freshmen to sophomore years was 41 of 47 or 87%. During 2015, the number of students in the Introduction to Infrastructure course who moved on to the sophomore year in CEE was 60 of 64 or 94%. Two of the 64 students in the Introduction to Infrastructure course in 2015 were not CEE majors, but both moved on to become CEE sophomores. In addition, one student in the Introduction to Infrastructure course in 2015 decided to move on to another engineering major before the semester began. However, freshmen engineering students at Rowan are required to complete their freshmen years in their original majors before they are allowed to move on to other majors in the sophomore year. Data for student retention for 2016 has not yet been compiled.

### **Theme of the Course**

As noted above, the theme of the Introduction to Infrastructure course for Spring 2015 was the impact of severe storms on infrastructure.

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For Spring 2016, the course transitioned to a broader theme dealing with the impact of extreme events on infrastructure. During Spring 2016, Dr. Morgan discussed the impact of global warming on infrastructure, especially as it relates to water resources engineering and environmental engineering. Special attention was paid to the impact of global warming on rivers, reservoirs, and dams. For Spring 2016, Dr. Dusseau continued to discuss the impact of Hurricane Katrina on the infrastructure of the Gulf Coast States of Louisiana, Mississippi, and Alabama. In particular, Dr. Dusseau discussed the impact of Katrina on the levee system of New Orleans and the bridges in Louisiana, Mississippi, and Alabama. Students were divided into teams of 3 or 4 students and required to write two term papers: one paper on the impact of climate change as it relates to water resources and environmental engineering and one paper on the failure of a bridge or levee during Hurricane Katrina.

Beginning in Spring 2017, Dr. Dusseau will discuss the impact of earthquakes on bridges, buildings, and lifeline systems. Dr. Dusseau will then alternate between the topics of hurricanes and earthquakes in alternating years. Team term papers will again be required during Spring 2017.

### Summary

A new course entitled Introduction to Infrastructure (I2I) was offered at Rowan University for the first time in Spring 2015. The course is required for all freshmen students in the Civil and Environmental Engineering (CEE) Department. The enrollment for the two sections of the course in Spring 2015 totaled 64 students. The course served to introduce freshmen students to infrastructure in general and to the fields of environmental engineering, water resources engineering, geotechnical engineering, structural engineering, and transportation engineering. The theme for the course during the first year was the impact of extreme storms on infrastructure. The impact of Superstorm Sandy on the water and wastewater treatment facilities in New Jersey was discussed. The impact of Hurricane Katrina on the levees in New Orleans and the bridges in Louisiana, Mississippi, and Alabama was also discussed. Student teams prepared term papers on the failure of one levee or one bridge as a result of Hurricane Katrina.

I2I was offered for the second time in Spring 2016. Enrollments were 74 students divided between two sections. The basic topics covered remained the same. However, the revised theme for the course was the impact of extreme events on infrastructure. While the impact of Hurricane Katrina was again covered, the impact of climate change on rivers, reservoirs, and dams was included in place of Superstorm Sandy. Beginning in 2017, the impact of earthquakes on bridges and lifeline structures will be discussed in place of Hurricane Katrina.

### Conclusions

The authors are pleased with the assessment results which indicate a positive impact of the I2I course on freshmen student knowledge and perceptions of infrastructure and civil engineering. The authors are also very satisfied with the student retention from the freshman to sophomore

years which increased from 87% in 2014 (without the I2I course) to 94% in 2015 (with the I2I course). Given the initial success of the I2I course, the CEE Department at Rowan University will continue to offer the I2I course as a required course for all freshmen CEE students.

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## Ralph Dusseau

Ralph A. Dusseau, Ph.D., P.E., graduated with his doctorate in civil engineering from Michigan State University in 1985. He taught at Wayne State University from 1985 to 1995. Beginning in 1995, Dr. Dusseau served as Professor and Founding Chair of the Department of Civil and Environmental Engineering at Rowan University. He is currently serving as Professor and Associate Chair of the department. Dr. Dusseau is a licensed professional engineer in the State of Michigan. His research interests include computer modeling and dynamic structural analysis of bridges and transit busses. Dr. Dusseau also conducts research in the area of engineering education.

**Jenahvive Morgan**

Dr. Jenahvive K. Morgan currently teaches EGR 100 - Introduction to Engineering Design at Michigan State University. For the past three years, she has taught freshman and sophomore engineering courses at Rowan University in Glassboro, NJ. Dr. Morgan has a PhD and MS in Environmental Engineering from the University of Michigan, and a BS in Chemical Engineering from Michigan State University. Her teaching experience includes work as a graduate student facilitator and engineering teaching consultant. She is a member of the American Society of Civil Engineers (ASCE) and is an ASCE ExCEED (Excellence in Civil Engineering Education) Fellow, 2014.

**Joseph Daraio**

Joseph A. Daraio, Ph.D. P.Eng, graduated from the University of Iowa in 2009 with a doctorate in civil and environmental engineering-hydraulics. He was a post-doc at Tennessee Technical University from 2009-2010, and a post-doc at North Carolina State University from 2010 to 2012 before beginning as an assistant professor at Rowan University. Dr. Daraio moved to a position as assistant professor at Memorial University of Newfoundland in St. John's in 2015, and is currently a licensed professional engineer in the province of Newfoundland and Labrador. His research interests are in water resources sustainability, modeling climate change impacts on hydrology and storm water infrastructure, and in the area of ecohydraulics.