Comparing First Year Engineering Students' Math and Verbal ACT scores and Performance in Introductory Engineering and Composition Courses.

Dr. Michelle E Jarvie-Eggart P.E., Michigan Technological University

Dr. Jarvie-Eggart is a registered professional engineer with over a decade of experience as an environmental engineer. She lectures in the Engineering Fundamentals department at Michigan Technological University. Her research interests include online learning, active and collaborative learning, sustainability and diversity in engineering.

Dr. Laura Kasson Fiss, Michigan Technological University

Laura Kasson Fiss is a Research Assistant Professor in the Pavlis Honors College at Michigan Technological University. She holds a PhD from Indiana University in English (2013). Her work has appeared in Victorian Periodicals Review, The Lion and the Unicorn, and The Cambridge Companion to Gilbert and Sullivan. In addition to her research on Victorian humor, she conducts higher education research and scholarship on issues of inclusion, reflection, and innovation.

Work-in-Progress -- Comparing First Year Engineering Students' Math and Verbal ACT scores and Performance in Introductory Engineering and Composition Courses

Michelle Jarvie-Eggart, Laura Kasson Fiss, Karla Saari Kitalong
Michigan Technological University, mejarvie@mtu.edu, lkfiss@mtu.edu, kitalong@mtu.edu

Abstract - **This work in progress paper attempts to uncover the links between incoming student ACT (math and reading/writing scores) and performance in first year engineering and compositions courses. Statistically significant differences were found, with incoming students possessing greater math than reading/writing abilities (as measured by ACT exams). However, average performance in first year composition and engineering classes displayed the opposite relationship.**

BACKGROUND

Much attention has been given to the link between incoming engineering students' math readiness and their performance in first year engineering programs. To promote retention in engineering programs, many first year programs now have separate classes for students in need of math skill development. But little is done to assess in-coming students' verbal or written communication abilities. Effective communication is essential for their success as engineers and is included in the new ABET requirements as Criteria 3, Student Outcomes 3, "ability to communicate effectively with a range of audiences" [1]. Many programs focus on assessing communication within the context of a final report or senior design project, at the end of a student's experience, but do not measure incoming students' baseline communication abilities to assess progress.

Developing communication abilities in future engineers is as essential as developing design abilities. In fact, engineers spend a majority of their time communicating. It has been shown that engineers spend over half their working days (55-60%) communicating both orally and in writing [2]. Additionally, communication is in the top three most important competencies ranked by engineering graduates (planning and time management is first; problem solving is second). Yet communication remains one of the skills engineering students struggle with the most, often failing "to appreciate that written words, not just calculations, express engineering content" [3]. The assumption is that engineers communicate with numbers, graphs and diagrams, not words.

This work in progress examines the data behind first year engineering students' performance in introductory engineering and composition courses, as well as their math and combined reading/writing/English (English Language Arts or ELA) ACT scores, to determine if there is a link between communication abilities and success in engineering curricula. Our ultimate intent is to determine if a remedial path might be needed for some engineering students when it comes to communication skills.

METHODS

Data from 247 first year engineering students for the 2016-2017 school year were collected from a Midwestern STEM-oriented US university. Information collected included each student's incoming math and ELA ACT scores, as well as final grades in first year composition (UN1015) and in the second class of a two-class introduction to engineering thinking and design series common to all engineering majors (ENG1102). Only students who completed both ENG1102 and UN1015 within their first year of college and earned numerical grades were included in this data set. Additionally, not all incoming students submit ELA ACT scores to the University. Only students with both math and ELA ACT scores were examined.

Mean math and ELA ACT scores were compared using a paired two-tailed t-test to determine if there was a statistically significant difference in the students' incoming math and verbal performance. Mean final course grades (on a 4-point scale) were compared using a paired two-tailed t-test to determine if there was a statistically significant difference in the students' performance in UN1015 and ENG1102. For both of these comparisons, a significance level α of 0.01 was chosen prior to data comparison to test the null hypothesis of no difference in the means.

An additional analysis was performed on 105 students with both sets of ACT scores, a grade in ENG1102, and transfer/placement credit in UN1015, looking at the mean

grades in ENG1102 and mean ACT scores (math, ELA, and difference between each student's scores).

Results

Statistical analysis showed a mean math ACT score of 28, with a minimum of 16 and a maximum of 35, and a standard deviation of 3.08. The mean ELA ACT score was 25, ranging from 15 to 35, with a standard deviation of 3.41. A paired, two-tailed t-test revealed a p value of 2.28×10^{-38}. Since the p value is less than the selected alpha, the null hypothesis is rejected and the 3 ACT point difference in the means is significant. The pivot chart below shows first year students' math and ELA ACT scores to visually represent the distribution of each.

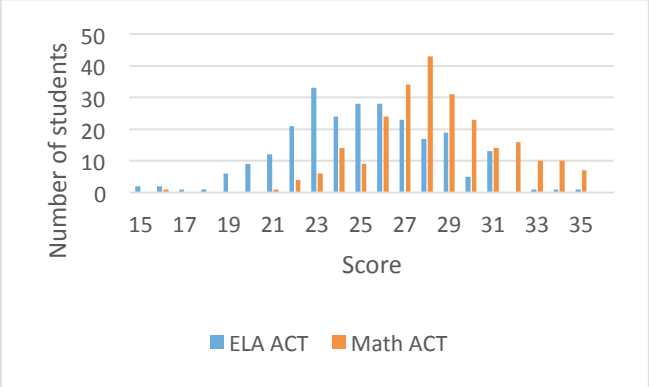

Figure 1
Scores on ACT Math and ELA

The pivot chart below shows the difference between math and ELA scores (as calculated for individual students).

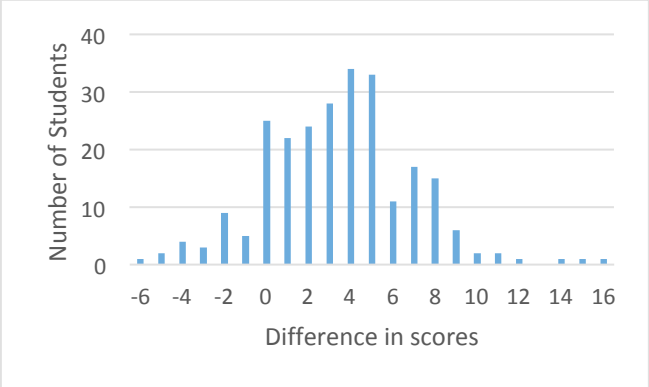

Figure 2
Difference between ACT Math and ELA

Our preliminary data about performance in courses is more ambiguous. It shows students in the same population earning higher grades (as an aggregate) in first-year composition than in the second half of the Engineering Fundamentals course. Grades in both classes ranged from a 0 (F) to a 4.0 (A). The average grade in Engineering Fundamentals was 3.24 (standard deviation of .78) and the average grade in Composition was 3.44 (standard deviation of .82). The average difference (as calculated for individual students) was 0.20. A paired, two-tailed t-test revealed a p value of 2.52×10^{-5}, indicating that the difference in the means is significant.

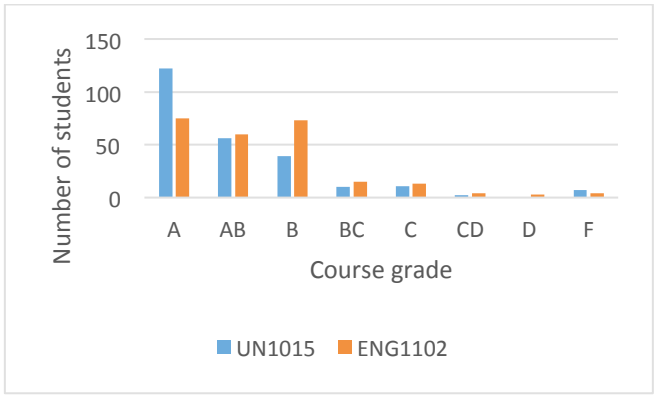

Figure 3
Grades in UN1015 and ENG1102

First-year students who placed out of UN1015, either through AP credit or transfer credit achieved a greater mean score in ENG1102: 3.45. These students had a mean math ACT score of 29, a mean ELA ACT score of 27, and a mean difference of 2.2 between their two scores (as individuals). When combined, the entire cohort of 364 students earned a mean grade of 3.30 in ENG1102.

Discussion

The mean math ACT score of 28 and mean ELA ACT score of 25 displayed a statistically significant 3-point difference for an alpha of 0.01. These results indicate that students entering the university are more highly functioning in their math abilities than in their reading/writing abilities (fitting the stereotype of most engineers).

Clearly, an aggregate discrepancy exists between the math and reading/writing skills of students in this university's engineering program. This relationship does not display as expected when examining performance in engineering and composition 1000-level classes. Although the average difference in course grades was 0.20 (about 5% of the available 4-point scale), the relationship was flipped in course performance with average grades in ENG1102 (3.24) being lower than the average grade in UN1015 (3.44). In essence, engineering students performed better on average in their first-year composition courses than first-year engineering courses, despite a lower average ELA score.

However, students who placed out of UN1015 indicate some correlation between skills in reading and writing and performance in ENG1102. These students had higher ACT scores in both math and ELA (29 and 27 respectively), with less of a difference in the mean scores as well as less of a mean individual difference. They also performed better in

ENG1102 by an average of 0.21 points, or 5%, than their peers who took UN1015 on campus.

Work thus far has only compared the mean student performance. Not all students fit this profile, however: some individual students had higher ELA scores than math scores. But still others had dramatically higher math scores, up to a 16-point difference. In our continuing research, we will examine the performance of students at either end of this range in first-year engineering and composition classes. We will also compare student performance in those classes in the higher and lower range of ACT verbal scores.

CONCLUSION

Results indicated a statistically significant difference in first-year engineering students' math and ELA ACT scores, with math scores being higher. However, these same students displayed a statistically significant difference in their mean performance in first year composition and engineering courses, with composition grades being higher. On the other hand, students who placed out of their composition requirement earned higher grades in their engineering courses. The data will be explored further. Additional investigation will examine the performance of those student populations with greater gaps between math and reading/writing abilities in comparison to students with balanced abilities in both areas. A wider data set will be sought, encompassing students who completed ENG1102 after their first year. Further work should address the nature of these two courses and their relation to the skills being tested in the math and ELA ACT tests.

REFERENCES

[1] ABET, 2017. "EAC Mapping C3 A-K to C3 1-7" Accessed online at: http://www.abet.org/wp-content/uploads/2018/02/C3_C5_mapping_SEC_8-15-2017.pdf On Feb 15, 2017.

[2] Passaw, H.J., & C.H. Passaw. 2017. "What Competencies Should Undergraduate Engineering Programs Emphasize? A Systematic Review." Journal of Engineering Education. Vol. 106., No. 3, pp.475-526.

[3] Conrad, S. 2017. "A Comparison of Practitioner and Student Writing in Civil Engineering." Journal of Engineering Education. Vol. 106, N0. 2., pp. 191-217.

AUTHOR INFORMATION

Michelle Jarvie-Eggart Senior Lecturer, Michigan Technological University, mejarvie@mtu.edu. Dr. Jarvie-Eggart earned her Ph.D. in Environmental Engineering in 2007 from Michigan Technological University. She is a professional engineer with a decade of industry experience working on environmental compliance and sustainability issues for mining and other extractive industries. She currently lectures in Engineering Fundamentals at Michigan Technological University. Her research interests pertain to sustainability, first year programs, and online learning.

Laura Kasson Fiss, Research Assistant Professor, Michigan Technological University, lkfiss@mtu.edu. Dr. Fiss is a Research Assistant Professor in the Pavlis Honors College at Michigan Technological University. She holds a PhD from Indiana University in English (2013). Her work has appeared in *Victorian Periodicals Review*, *The Lion and the Unicorn*, and *The Cambridge Companion to Gilbert and Sullivan*. In addition to her research on Victorian humor, she conducts higher education research and scholarship on issues of inclusion, reflection, and innovation.

Karla Saari Kitalong, Professor, Michigan Technological University, kitalong@mtu.edu. Dr. Kitalong is Professor of Humanities at Michigan Technological University, where she previously directed the composition program and the Multiliteracies Center and currently serves as director of the program in Scientific and Technical Communication. Her research interests include usability of technical communication products; multimodal composition theory and pedagogy; and writing program administration.