AC 2008-2389: BANG HEAD HERE: FIRST YEAR INSTRUCTORS DEALING WITH STUDENT FAILURE

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Abstract

As first-year Instructors in the Department of Civil and Mechanical Engineering at the United States Military Academy at West Point, we are highly motivated, extremely dedicated, and well-trained teachers. Fresh from graduate school and the Civil and Mechanical Engineering Department's famous 6-week Instructor Summer Workshop, we were excited as our first semester started. We were eager to get into the classroom and lead our gifted students to academic victory. Our students, cadets who competed rigorously to come to our institution, are some of the brightest college students in the country. They have chosen engineering as their major and future profession.

However, once the semester was underway we found that despite our training, motivation and effort, we still had students fail and perform poorly on exams. Why do dedicated, disciplined, and driven students who want to be engineers fail? Is our instruction not meeting these particular students' learning needs? Are the lessons built with proper attention to building student learning through the cognitive domain? Is it a lack of motivation caused by outside influences? Is it a result of another academic failure or tragedy that creates a cycle of poor performance? Are their study habits poor? Or, could it be that these students simply do not understand the material? This paper investigates the possible sources of failure of cadets enrolled in two introductory Civil Engineering courses that are taught by new instructors.

Introduction

The purpose of this paper is to investigate a common source of frustration of many new engineering educators. That source of frustration is student "failure." As first year instructors, we, naively, believed our students would all get A's and B's. Sure, we had learned about struggling students and student failure, but we wouldn't have those problems because we were a couple of motivated, well-trained and intelligent teachers. We also perceived all cadets to be "high-speed, low-drag, super-duper-paratroopers," - smart and driven individuals who chose to enroll in an engineering major, therefore possessing the two main characteristics required of a successful student. As the semester progressed, we found that the perceptions of our time as former successful cadets may have skewed our perceptions of our abilities and those of our students. We wanted to determine why the students failed and if there was a common factor that led to their lower performance.

Scope

We wrote this paper from the perspective of two first-year instructors seeking to understand student failure. We hope this paper serves as a tool for other new instructors to understand why students may not perform well, so they can adjust their methods to avert potential student failure. To facilitate this academic journey, we defined student failure and then interviewed those students who should have performed better in the class. Through interviews and surveys, we

attempted to identify causes that affected their study habits and hindered their development of knowldege in the cognitive domain[1], or created a decrease in their motivation and negatively influenced their motivation as defined by the affective domain[2] for the course material.

Background

The United States Military Academy at West Point (USMA) has invested significant time, effort, and money to develop a strong civil engineering faculty that is motivated and capable of providing excellent engineering instruction. The Department of Civil and Mechanical Engineering uses the ASCE Body of Knowledge (BOK) Committee's recommended characteristics of full or part-time engineering faculty members.[3] The department looks for faculty who are scholars, effective teachers, have practical experience, and serve as positive role models. [4]

New Instructor Scholarship

The BOK Committee defines scholars as faculty that "acquire and maintain a level of expertise in the subjects they teach," and who are "life-long learners, modeling continued growth in knowledge and understanding."[3] The authors of this paper fulfill this criteria. MAJ Crispino graduated third in his class from the United States Military Academy with a BS in Civil Engineering in 1998 . He was ranked first of the CE majors that year. He received a MS in Civil Engineering from Virginia Tech in 2007. MAJ Chalmers graduated from the United States Military Academy with a BS in Civil Engineering in the top 10% of his class in 1997. He continued his scholarly development by receiving an MS in Civil Engineering (General) from the University of Missouri at Rolla in 2001, and by receiving another MS in Civil Engineering (Structural) from Stanford University in 2007. Over the last 15 years, both professional US Army officers have committed themselves to achieving and continuing increased scholarly growth.

New Instructor Teaching Effectiveness

The BOK Committee further defines effective teachers as "faculty members who effectively engage students in the learning process" and that engineering faculty members must be developed "as effective teachers."[3] As new instructors in the Department of Civil and Mechanical Engineering at the United States Military Academy, we took a rigorous and effective six-week Instructor Summer Workshop (ISW)[5] that ASCE uses as its model to give civilian engineering educators in its Excellence in Civil Engineering Education (ExCEEd) workshop.[6] This ISW contains numerous seminars from second-year instructors who help us understand the challenges of being a new instructor, and provide us with practical solutions to the challenges we will face. We learn Bloom's Taxonomy[1, 2], learning styles from Lowman[7], and multiple teaching techniques and tools to be effective teachers from Wankat and Oreovicz.[8] This culminates in preparing and teaching six lessons to the senior faculty who provide detailed and constructive feedback to improve our effectiveness in the classroom. Once the semester starts, we are also encouraged to engage our cadets outside of the classroom.

Our senior rater and immediate supervisor provide formal written counseling where we discuss the five pillars of success for engineering faculty. Those five pillars are Teaching, Faculty Development, Cadet Development, Scholarship, and Service.[4] Our senior faculty encourage us to be active in all five areas, but to be experts in two. As first-year instructors, we are typically focused on Teaching and Cadet Development. These two pillars directly correlate to the first two characteristics the BOK Committee consider essential to good engineering educators. To develop the cadets and to increase engagement, we do many activities outside of the classroom. Between the two of us, we have acted as Faculty Advisors to the Civil Engineering Club (ASCE Student Chapter) and spent many hours developing cadet leadership within Civil Engineering educational activities and social events. We have attended cadet sporting events, greeting and encouraging all of them to let them know we cared about them outside of the classroom. For the civil engineering Firsties (seniors) we have a private social gathering where we teach them home brewing in an informal atmosphere and they learn proper social etiquette and moderate alcohol consumption. In addition, we perform duties as the Academic Officer in Charge (AOC) where we inspect cadet living and study conditions from 1930-2330 at least once a semester. This allows us to gauge how well cadets are able to study at night, and it allows us to visit our students in their rooms and see how they are doing at a very personal level. Each instructor also participates in a CE489 Individual Study Project, that allows a group of cadets, or an individual student, to devise, solve, and execute the solution to an open-ended engineering problem. Finally, each faculty member is encouraged to sponsor cadets as formal mentors. We each have six to ten cadets that we periodically invite to our homes on weekends to relax, have dinner, do laundry, watch television, or entertain with war stories. Through all of these varying extracurricular activities, we create relationships that increase the engagement with the cadets in the classroom.

In the classroom, we learn techniques to further increase the cadet and instructor engagement. The interaction in the classroom is essential to active learning. We shun lesson plans that are predominantly run on slide shows, and we practice different questioning techniques that ensures every cadet gets at least one question per class session. The questions have to be challenging and varying because the "low-hanging fruit" questions may be easy to answer, but will eventually lose the cadet's interest.[9] By preparing questions before class that are synchronized with our lesson notes, we bring the cadets along with us as we develop new engineering theories and solve problems that are new to them. While we write our notes on chalkboards, we maintain cadet interest and engagement by using five colors of chalk; using many pictures and visual diagrams; and music, short slide shows, and the text all in the same lesson. Usually, we create physical demonstrations that require cadet participation and it gets students out of their seats and into the class material first-hand. Finally, we also ensure that we physically move around the classroom as we ask questions and provide positive encouragement with good dialog and eye contact to increase student confidence and to encourage maximum classroom participation.

These two approaches to creating positive student-teacher interaction, lead to great classroom engagement that facilitates positive learning in engineering courses. The approaches attempt to achieve high levels of combined intellectual excitement and interpersonal rapport, which have been defined as the path to the exemplary teacher according to Lowman.[7] The extensive teaching instruction given to new engineering educators at our institution creates effective teachers. Combined with the extracurricular activities and in-class teaching techniques that

effectively engage students, we feel that we meet the definition of Effective Teachers according the BOK Committee's definition.

Practical Experience

Of the BOK Committee's four essential characteristics of the engineering educator, Practical Experience is our weakest area. The BOK Committee defines Practical Experience as "practical experience in the engineering subjects" instructors teach, and that "most civil engineering faculty should hold a professional engineering license."[3] MAJ Chalmers is an officer in the US Army Corps of Engineers, is a registered Professional Engineer in Missouri, and has conducted multiple construction projects in training and in combat supporting the Global War on Terrorism. MAJ Crispino is a Field Artillery officer and an Engineer in Training. He is currently preparing to sit for his Professional Engineer's license. We have the practical experience needed to satisfy the BOK Committee's definition for an engineering educator.

Positive Role Models

Lastly, the BOK Committee feels that all engineering educators should act as Positive Role Models. They state that "every civil engineer who is in contact with students serves as a role model for the profession. Those who teach should be aware that students view them in that light."[3] This characteristic is part of the very fiber of a US Army officer, and is emphasized at the institutional level at the US Military Academy, and within the Department of C&ME.[4] Our end of course reviews provide results that prove cadets see USMA faculty as positive role models, and that engineering faculty in the department earn higher marks for professionalism and act as better positive role models than instructors from other departments. Again, we feel that we meet the requirements as Positive Role Models for our students as required by the BOK Committee.

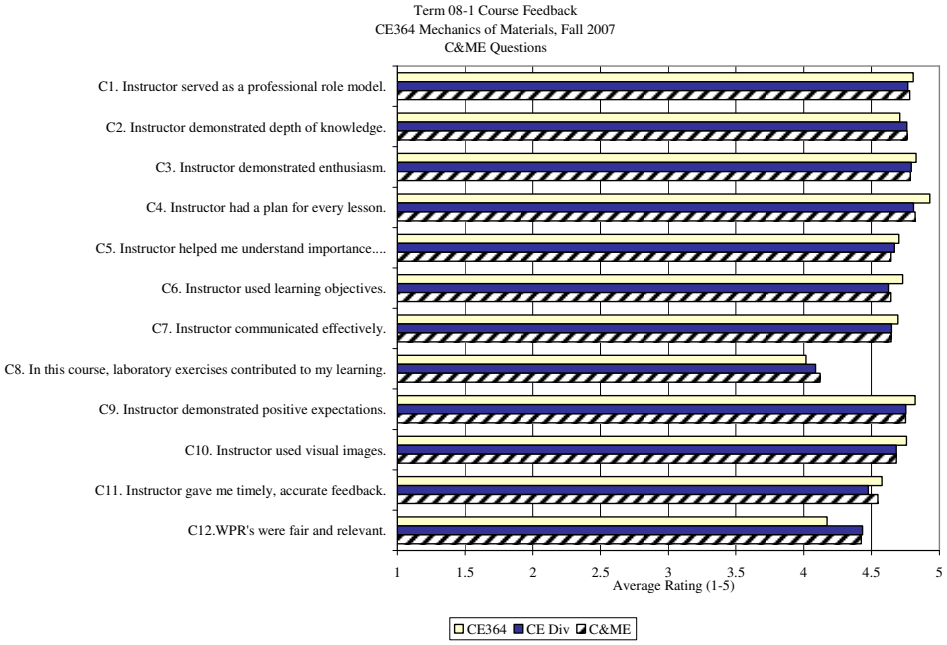

Figure 1 – Student course end survey results comparing course survey results between CE364, the entire CE division, and to the Civil and Mechanical Engineering Department

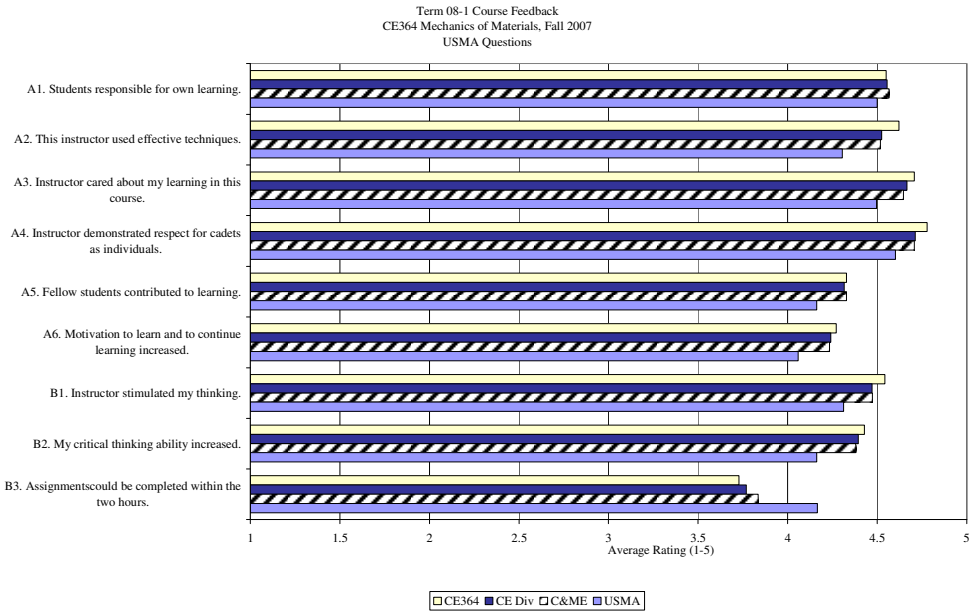

Figure 2 – Results of student course end survey results of standard USMA questions for CE364, the entire CE division, the Civil and Mechanical Engineering Department, and all USMA academic departments.

Given the fact that we satisfy all four characteristics of the model for a civil engineering faculty member as defined by the ASCE BOK Committee, we feel that we are providing outstanding instruction and mentorship to our engineering students.

Our Students

Our students are smart, dedicated, and motivated to learn. Each individual had to endure a rigorous application process to enroll at USMA, and did so understanding that upon graduation they will see combat. Their dedication to their country and their ultimate goal of becoming US Army officers is not in question. They are driven to do well in their classes because their academic standing accounts for 65% of their order of merit (OML) within their graduating class. This OML determines the branch or specialty that they can select, their post selection, and it will determine promotion dates later in their careers. Cadets understand this importance and as a result, they try very diligently to succeed.

As Yearlings, (sophomores), they choose their majors. Students that choose an engineering major will take CE300 Fundamentals of Engineering Mechanics and Design, and CE364 Mechanics of Materials. Students that do not choose an engineering major must choose an engineering sequence or track of three engineering courses from one of the engineering departments. Students that choose to take the civil engineering track or the mechanical engineering track will enroll in CE300. Although we have liberal arts students in some of our classes, they chose to take our courses over other engineering disciplines. Therefore, the students enrolled in our classes want to be there.

The average incoming GPA, on a 4 point scale, for CE300 this semester was 3.08 for 183 students, and in CE364 it was 3.25 for 152 students. Compared to other majors, cadets majoring

in Civil and Mechanical Engineering have a higher GPA. Other majors have an average incoming GPA of 2.95, whereas the C&ME majors have an incoming GPA of 3.24. This incoming GPA is for sophomores who have completed most of their core liberal arts, mathematics, chemistry, and physics requirements. This difference clearly shows that the academic caliber of C&ME students is higher on average than other departments.

From these factors, we can determine that the students in our courses are intelligent, interested in the material, they want to be in our classes, and that they want to get good grades.

Methodology

To investigate why all of our students did not get A's and B's, we had to determine and define what constituted failure for a student. A student that received a failing grade of D or F clearly demonstrated a failure to grasp and apply the course material. But did a cadet fail if they achieved a C- or a B- for a grade? We devised a numerical method to clearly delineate what classified a failing performance. At the author's request, the Dean's Office tabulated each student's grades for all of their courses while at the academy in numerical format. We then conducted a quick statistical analysis with a normal distribution to determine the mean (GPA) of each cadet's grades and then found one standard deviation. The standard deviation in the negative tail of the normal distribution provided the metric to determine failure for each student. If a student's final grade in our course fell within that negative tail, or below one standard deviation from their incoming GPA, then we felt that this showed a negative change in past performance for that individual student. We conducted this analysis on six sections of students that we taught as new instructors in two different beginning engineering courses. We also conducted the same analysis on four sections of students that were taught by more seasoned and senior instructors in the same two courses. This allowed us to make conclusions of how teaching experience may have influenced the students that "failed."

After we identified the students who underperformed, we asked them to fill out an anonymous, ten-question, web-based survey. The intent of the survey was to help identify possible sources of frustration or outside distractions that may have negatively impacted the student's performance. We combined this survey's response to the end of course critiques for both CE300 and CE364 to give us more insight into the student's perceptions of their abilities, what they thought caused their substandard performance, and how they viewed the course material and instructors.

We then took the results of an analysis conducted within the C&ME department that evaluates the effectiveness of the ITW. The analysis compares the results of the end of course critiques of incoming new instructors to the critiques of the more seasoned instructors. We used the results of this analysis to see how our performance as new instructors was in relation to more seasoned instructors, and to determine if there was a perceptible correlation between our student's grades versus the performance of the more seasoned instructors' students. Lastly, we considered if a section's incoming GPA served as an indicator for student failure.

Results and Discussion

The results of our statistical analysis to identify cadets who under-performed is presented in Table 1. A student could be classified as a failure while receiving a decent grade of a B or B-. Our methodology isolated the performance of the individual student, and evaluated their performance in class based on their own grades. We took the number of failures and determined the failure rate of each instructor based on their student population in each section. The results showed that each instructor had failure rates that did not necessarily relate to teaching experience. Significantly, one of the seasoned instructors had no identified failures versus another seasoned instructor had a 12% failure rate. The new instructors had statistically comparable results for failure rates. The significant conclusion from Table 1 is that teaching experience may not necessarily impact the rate of student failure. This is counterintuitive, but is important to consider that a well trained teacher is as effective as a seasoned professional.

Table 1 - Results of the statistical analysis which identified student failures.

Instructor Experience	Course	Cadet	Grade	Failure Rate
New Instructor	CE364	J.J.	B-	5.77%
New Instructor	CE364	I.J.	C+	
New Instructor	CE364	J.S.	D	
Seasoned Instructor	CE364	B.B.	D	12.5%
Seasoned Instructor	CE364	M.S.	D	
Seasoned Instructor	CE364	S.T.	C	
Seasoned Instructor	CE364	C.W.	F	
New Instructor	CE300	A.C.	C-	9.09%
New Instructor	CE300	L.E.	C-	
New Instructor	CE300	K.H.	B	
New Instructor	CE300	N.M.	F	
Seasoned Instructor	CE300	N/A		0.0%
Seasoned Instructor	CE300	N/A		

Table 2 illustrates the relationship between instructor experience, incoming GPA as a measure of student ability, and the resulting number of student failures. This table shows that there is not a clear relationship between student failure and instructor experience, and that there is not a clear relationship between incoming GPA and the number of failures.

Table 2 - Relationship between instructor experience, incoming GPA and the number of resulting failures.

Instructor Experience	Course	Incoming GPA	Failures
New Instructor	CE300	3.16	1
New Instructor	CE300	3.15	1
New Instructor	CE300	3.00	2
Seasoned Instructor	CE300	3.04	0
Seasoned Instructor	CE300	3.14	0
New Instructor	CE364	3.29	2
New Instructor	CE364	3.35	0
New Instructor	CE364	3.41	1
Seasoned Instructor	CE364	3.22	2
Seasoned Instructor	CE364	3.11	2

The results of the anonymous survey completed by 9 of the cadets who failed last semester are shown in Figure 3. The responses to questions 4a through 4d showed that the cadets who did not perform well, generally had a favorable impression of their instructor. The cadets who participated in the survey also indicated that the instruction was adequate as shown by the response to question 9.

From the survey results there does not appear to be a single source of student failure. It is interesting to note that the response to question 1, "How important was this course to you in your overall education?" the average response was 3.44 – slightly above neutral. The response to question 2 "Were you challenged in *other* courses this semester?" was particularly high. Also interesting to note is the response to question 8 "Did the course appeal to your learning style?" The average response to this question was 3.67, which is rather low considering that new West Point faculty undergo significant training on how to ensure their presentation appeals to a wide range of learning styles. The data from this survey is by no means conclusive, but there is a slight indication that the students who performed poorly did not place an especially high priority on the course and instead chose to respond to the challenges faced in other courses.

The results of the survey also suggest that distractions such as cadet chain of command duties, extracurricular activities, and personal distractions did not have a large role in student performance as shown with questions 3, 5, 6, and 10. The average responses to these questions were all very close to neutral.

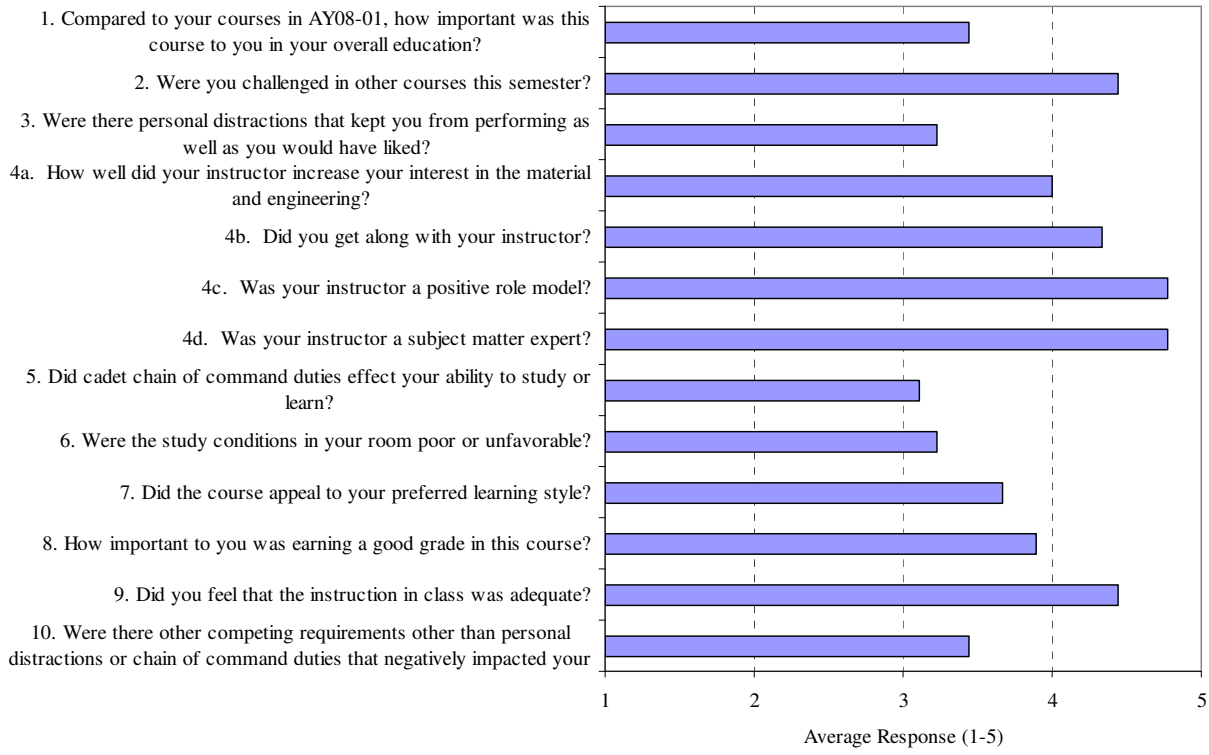

Figure 3 - Survey results completed by cadets who "failed"

When we questioned some of the survey respondents individually to help clarify their answers, they clearly stated that they enjoyed the classroom instruction and their instructors. These verbal responses correlated with their survey results for questions 4 and 9. This shows that the emphasis on interpersonal rapport and intellectual development works and that the students like it. However, they were not clear what their learning style really was, despite taking surveys that determined their learning style at the beginning of the course, and that may have impacted their response to question 7.

The students clarified that they did want a good grade because of the importance of grades for choosing their military branch or specialty, and to determine their first post assignment. However, they did not place much importance on the class compared to their other classes. The reasons for this lack of importance varied. One student proved that one of our assumptions that our cadets wanted to be in the class was false. The student was "forced" into the civil engineering track sequence of three classes, and therefore did not want to be there. That student's motivation to show up to class and do the work was low. Another student said that other courses were easier, and therefore it made more sense to do better in those classes to increase their overall GPA. The large amount of work in the civil engineering courses caused a "time value of points" analysis by the students. They decided that they would get better grades in less time by focusing on other classes. This type of strategy is a survival method for struggling students.

The numerical responses to questions 3, 5, 6, and 10 did not show a strong trend of outside influences impacting the student's behavior. However, when we questioned them in person, they described a more profound impact from military duty responsibilities, medical issues, personal events, and other outside influences. These issues were also captured in the additional commentary within the online survey and mirrored the verbal discussion held with the students. From this we decided that these random outside influences can impact a few students more severely than others and is something that new instructors should watch for in about 5% of their students. Identifying students that have these distractions and negative influences from outside of the classroom need help. The assistance they require may be additional instruction to a sympathetic listener who can empathize with them and offer sage advice gained through personal life experience.

Figure 4 shows historical results from the last of the course critiques by cadets of new instructors compared to the surveys for more seasoned instructors for the last two years. Clearly, the students do not perceive a statistical difference between the performance of new and more seasoned instructors. Students see the in-classroom techniques and effectiveness exhibited by all instructors within the department as equally excellent.

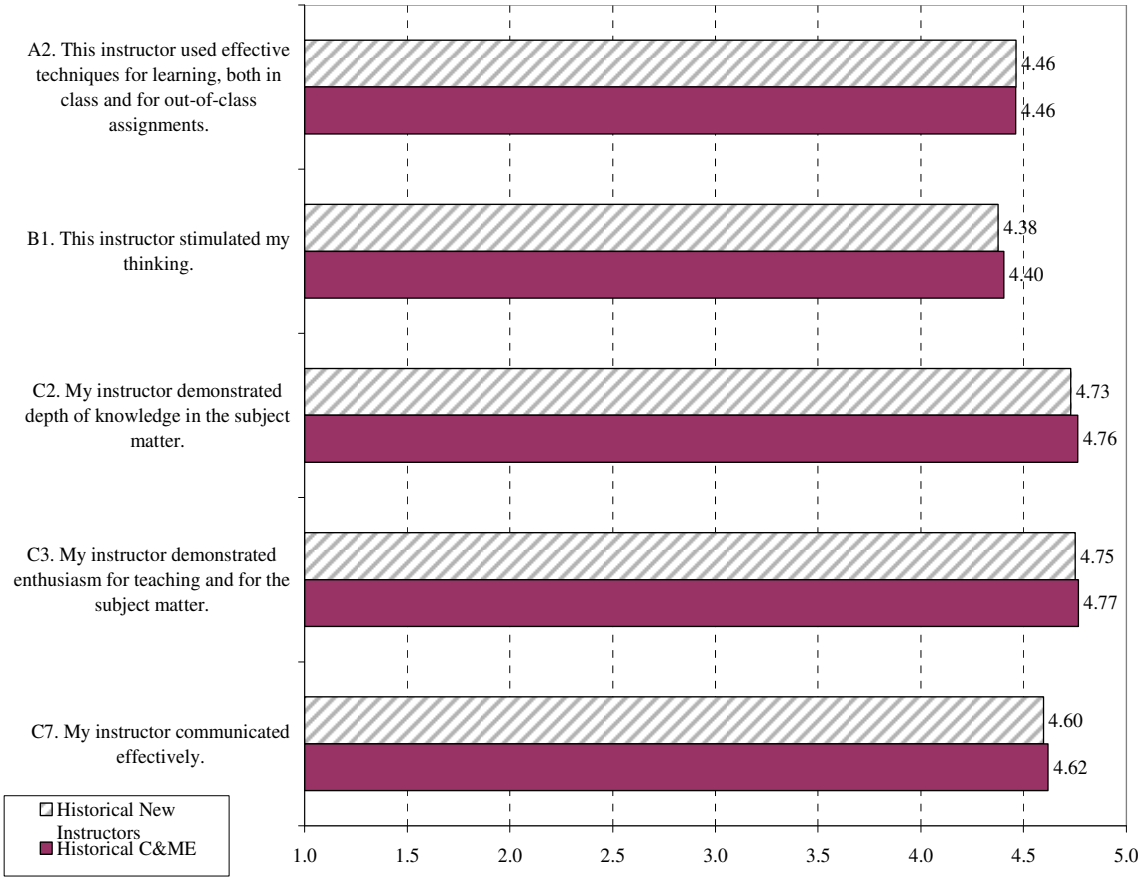

Figure 4 – New instructors vs. department as a whole

Conclusions

By investigating the sources of student failure from the perspective of new instructors, we found no significant source of failure, that our failure rates were very low, and that our department's new instructors' performance was equal to the performance of more seasoned instructors. There was no bad rapport or decreased student engagement for new instructors compared to more seasoned instructors that resulted in student failure in the cognitive domain.

Incoming GPA did not clearly indicate future cases of cadet failure. The suggested indication and explanation for failure comes from the student's value of the class, and the priority of getting a good grade in that subject.

An interesting result was that we did not find a single, main, glaring reason for cadet failure. It was not the fault of new instructors or seasoned instructors. Student failure was not caused by any one influence or event from outside of the classroom. Instead, we found that new instructors had similar failure rates as seasoned instructors, and that our students perceived our in-class performances to be equal. This is not what we expected to find as we started our research. We thought we could find the reason to explain our student's failures. What does this mean?

From those interesting and unexpected results we determined that our department ensured student success and consistent results over many years by adhering to the ASCE BOK recommendations for characteristics of successful engineering educators. It also gives additional

credence to the department's Instructor Summer Workshop that teaches new instructors proper engineering educational techniques and theory, applied and learned through hands-on experience. The teaching techniques that influence the cognitive domain and the intellectual development are effective.

Recommendations

We recommend that more engineering departments take a hard look at the ASCE BOK for the characteristics of engineering educators and develop a long term program to hire and train their instructors to develop those suggested successful characteristics. New instructors should demand that they receive demanding, in-depth, and hands-on classroom instruction and theory on teaching engineering education such as ASCE's ExCEED program. These two actions will directly reduce student failure rates for new and seasoned instructors alike.

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