Student Perceptions of Technical and Soft Skills Development in an Introductory Automotive Engineering Technology Course

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Abstract

A key issue that engineering and engineering technology faculty face is the perceptions by students on their own skill levels, as they enter academic programs. Faculty must take students, many of whom were high achieving students in their primary education and develop new skills and habits necessary to be engineers, such as problem definition and formulation or teamwork. As part of an introductory course in automotive engineering technology course, students were asked to take a series of surveys, which included questions on their experiences and perceptions of their own skill levels in both technical skills and "soft skills", such as project management and conflict resolution. Throughout the academic term, the students were required to work both in subgroups and as a course-wide group on an automotive engineering technology project, requiring both technical understanding and interpersonal skills. Students were observed to have an increase in technical understanding, but did not rate their own technical or soft skills as having grown.

Keywords

Engineering Technology, Professional Skills

Introduction

As students enter their studies of engineering and engineering technology, many have preconceived notions of necessary engineering skills, focusing on the mathematical and science-based analysis and technical skills. While a majority of their training in engineering and engineering technology programs focuses on these types of skills, it is necessary to develop soft skills, such as teamwork and project management [1]. These skills are significant as part of student growth and are vital as students transition into the industry and becoming engineers. Some of the knowledge, skills, and abilities that students listed that their training less than "good" are soft skills, such as conflict resolution, mentoring skills, and cultural awareness [2].

One key part of developing these skills is to have students understand their skill level properly and to know if there are skills that the student should improve upon. Unlike more technical skills, like analysis of a system, which normally is assessed through homework assignments, tests, and other assessment methods, soft skills are not conventionally assessed in progress of a course. These skills can be developed throughout project work and design projects, or through extracurricular team projects. Yet these methods generally don't incorporate feedback on the Without direct feedback on the development of soft skills, students can overestimate their skill development, especially in the early phases of learning and for students who are on the lower end of skill development [3]. One recommendation to improve these skills is to incorporate independent, student-driven project work, where students can practice these skills [2].

There have been studies into the effects of extracurricular activities on various program objectives, in technical and soft skills. In data collected on the perception of students on various technical and soft skill sets, Akop et al. showed that extracurricular activities had an improvement on multiple skill sets, such as communication and professionalism.[4] Crockett et al. highlighted that student lead projects can reinforce University Learning Objectives, such as "interdisciplinary problem solving and communication with an appreciation for varied points of view, backgrounds, and skill sets."[5]

The focus of this study was to investigate the growth of soft and technical skills throughout an introductory course in automotive engineering technology at multiple points during the semester, as part of a large-scale project for the development of a student lead design team. The experimental objective was to observe how students working in design teams early in their academic careers expand their soft skill and to observe if students perceive their own growth, as well as observing their development. Throughout the project, students were asked to read through the design requirements, understand how the requirements would affect their subteam, and put together an overarching design document the design team would follow moving ahead.

Methodology

In order to measure the technical and soft skill development of students throughout the project, students were requested to complete pretests, at the beginning of the semester, and a post-test during the project, approximately three quarters the way through the semester. The number of respondents for each of the assessments are shown below in Table 1.

Table 1- Assessment Data

Assessment	Number of Respondents
Pretest	27
Post-Test	22

For the assessments, students were asked 10 technical questions, covering comprehension of major technical material covered in the course. Students were asked not to use outside resources on the assessment, on the following topics:

- Octane and Diesel Fuel Injection
- Brake System Design
- Lubrication Systems
- Oil Weight and Viscosity
- Battery Chemistry
- Electric System Design
- Impact Attenuators
- Aerodynamic
- Suspension Dynamics

There was also a question asking students to strongly agree, agree, neither agree or disagree, disagree, or strongly disagree with the statement, "I have a good technical understanding and skills in automotive engineering technologies". Students were also asked to self-assess of their soft skill level matching the questions asked in Mears et al.[1] For soft skill development, students were asked to rate their skills on:

- Project Management
- Conflict Management
- Coding
- Requirements elicitation and documentation
- Design
- Risk Management
- Teamwork
- Quality Assurance

Students were asked to rate their skill level based upon 5 levels: very little, not much, neutral, very much, and a great deal.

Throughout the course, students started work on developing a new vehicle and new racing team, including a feasibility study on the competition requirements (requirements documentation), requiring multiple sub-teams to work together on a collaborative design. The sub-teams include powertrain, chassis, aerodynamic, electronics, and steering/suspension designs, as well as safety and public relations considerations. As part of the project, students would experience each of the soft skill categories.

Results

The results of the pretest and post-test technical assessment scores are shown in Figure 1, showing that the students showed a 37% increase in technical knowledge. Only one of the 10 questions had a lower result on the post-test than the pretest, on gasoline fuel injection methods.

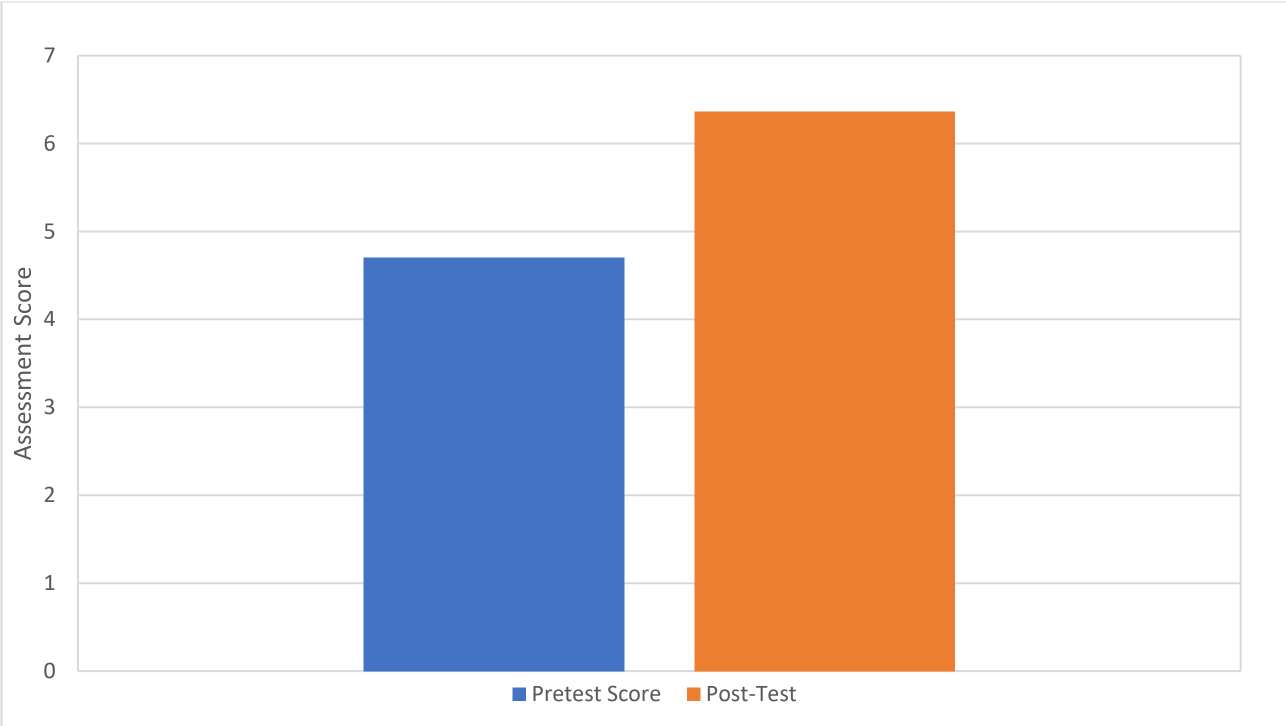

Figure 1- Results of Student Assessments (Pre and Post-Tests)

A statistical analysis of the pretest to post-test technical results showed a statistically significant increase in technical knowledge, with a p-value of 0.0196. The comparison of student's self-assessment of their technical ability was done, where a student strongly disagreeing with the statement was rated as a 1 going to a strong agreement set to a 5. The average for the pretest was a 3.33, and for the post-test was a 3.40, showing no significant increase in student self-assessment of technical skills.

With regards to the soft skill analysis, with the results shown in Figure 2, As observed there was little change in the scores of most of the soft skill scores between the pretest and post-tests, while the students participated in the project. None of the individual skills showed a statistically significant results, with the closest result (on requirements elicitation and documentation) having a p-value of 0.11, with most other results having a p-value above 0.5.

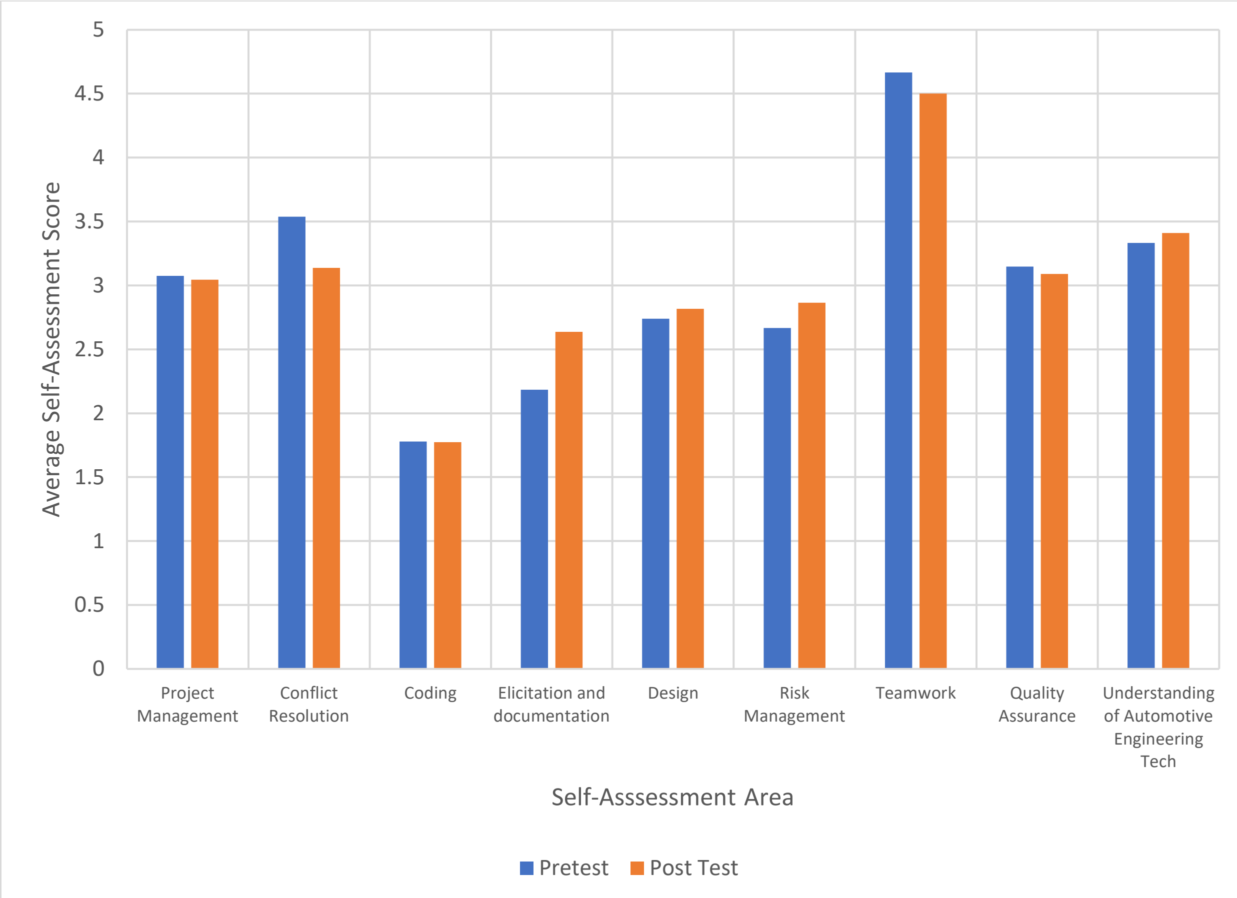

Figure 2- Self-Assessed Scores of Soft Skills

While the results show the students do not rate their skill level as having increased, students did have opportunities to practice these skills, but with much of soft skill development, it is less apparent than other, more technical skills. Also of note, in a comparison between the scores observed in Mears et al. [1] and this study, are the values that some of the students, in this study, provided in this self-assessment. In Mears et al., the participants in the study were graduate students in an advanced program in automotive engineering, whereas in this study, most of the participants were underclassmen (first- or second-year students). The students in this study would rate themselves higher in some skills, specifically in conflict resolution, risk management, and in teamwork skillsets. The students in this study could possibly have some experience in these skills (as many of students in this program do work outside of school in local automotive retailers, auto parts distributors, or in other relevant positions), but another reason could be due to the students having little experience or reference to their skill level in soft skill development. This could be an artifact of the Dunning-Kruger effect, observed in technical and non-technical fields [6–9].

In future investigations, it would be beneficial to include other assessment methods, such as peer-reviews of these skills [10] or through the use of other tools, such as e-TAT tool [11]. Also in future studies, it would be beneficial to include a wider range of levels in the self-assessments to show any statistically significance (more than 5 levels of each of the self-assessment scores).

Conclusions

In observations of students in an introductory automotive engineering technology program in the development of both technical skills and soft skills throughout the semester, it was observed that

- While technical skills saw a statistically significant increase between the pretest and post-test results, there was not an increase in student perception of their technical skill level
- Students did not show a statistically significant increase in soft skills over the course

Further research will focus on the influence of feedback for soft skill development.

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James Kribs received his PhD in Mechanical Engineering from North Carolina State University in 2013. He is an Assistant Professor in the Applied Engineering Technology department at North Carolina A&T State University, where he teaches courses in Automotive Engineering Technology. He is a member of the American Society of Engineering Education, the American Society of Mechanical Engineers, and the Combustion Institute.