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Career Advantages of Business Education Courses for Engineering Management Students

Dr. Saeed D. Foroudastan, Middle Tennessee State University

Dr. Saeed Foroudastan is the Associate Dean for the College of Basic and Applied Sciences (CBAS). The CBAS oversees 10 departments at Middle Tennessee State University. He is also the current Director for the Masters of Science in Professional Science pro

Suzanne S. Hicks, Middle Tennessee State University

Evaluation of Impact on Employability of Business Education Courses in a Master's Engineering Management Program

Abstract

Many graduates with strong engineering management skills enter the workforce, yet they often lack the soft skills our industry needs. Middle Tennessee State University's (MTSU) Master of Science in Professional Science (MSPS) program in Engineering Management has incorporated these desired soft skills into its core curriculum. This cross-disciplinary program provides Middle Tennessee with the best-educated and well-trained scientific workforce. The program was awarded the U.S. Department of Education's Graduate Assistance in Areas of National Need (GAANN) grant for Engineering Management (2019-2022), which supported nine students with a stipend, full tuition, and fees.

In 2023, the MSPS program completed a review outlining its successes in enrollment, graduation, and employment rates. Here, we analyzed data collected by internship employers from the 2015-2023 academic years to investigate the impact of MSPS business education on students' work performance. When evaluated by internship supervisors, MSPS student interns are continuously rated above average in their performance compared to other employees or in accordance with the achievement of objectives. As a result of this innovative program, seventy percent of our students receive a job offer from the place of internship, and ninety percent of our graduates have a job offer by the time they graduate. Students typically make between $75,000 and $85,000 annually and are promoted to managerial roles quickly.

The MSPS program prepares students with science, technology, engineering, and math backgrounds to take on management roles when they enter the job market by providing them with the skills needed for a successful career. A compelling aspect of this program is the capstone internship. Students have the opportunity to gain exposure to their field of study. Students and their internship employers report that the MSPS program coursework prepares students for a successful internship. The internship program is mutually beneficial for the student and the employer. The students are continuously rated with above-average skills, including interpersonal skills, knowledge of concentration, oral and written communication, quality of work, and overall performance, which are all vital in their respective fields.

Introduction

The Professional Science Master's (PSM) degree arose in the late 1990s to fill a gap between overqualified PhDs and underprepared undergraduates in science fields [1]. PSM programs provide graduate-level science training plus professional skills valued by employers [2]. The advantages of PSM degrees include career preparation, practical experience, high employability, networking opportunities, specialized knowledge, and lower cost versus a PhD. The PSM aligns with best practices proposed for master's degrees by higher education organizations [3], [4], [5].

MTSU's PSM program (MSPS degree) meets the requirements for formal PSM affiliation [6]. The interdisciplinary MSPS integrates science and business coursework, has an employer advisory board, teaches professional skills, and requires an internship. Research shows that while engineering grads have technical expertise, they often lack the soft skills employers need, like communication, collaboration, and strategic thinking. Studies advocate incorporating interdisciplinary team projects, simulations, and emerging technologies into STEM curricula to systematically build these skills [7]. Soft skills training also helps women transition into STEM careers [8]. Comprehensive STEM education that develops leadership abilities alongside technical competencies allows graduates to thrive in global corporations [9]. However, gaps in soft skills from education persist, pointing to a need for increased soft skills training integrated into STEM curricula through proven techniques to prepare graduates better.

The MSPS program in Engineering Management (ENMA) at MTSU has incorporated many of these desired soft skills into its core curriculum. This cross-disciplinary program provides Middle Tennessee with the best-educated and well-trained scientific workforce. The ENMA concentration at MTSU was started in late 2013 to provide Middle Tennessee's booming manufacturing industry with graduates trained in process improvement and engineering systems management. ENMA students become certified in the process improvement methodologies of Six Sigma, lean manufacturing, and project management, plus additional coursework in safety and engineering management principles. We have summarized the technical and soft skills taught in each of our courses and given the importance of each skill to engineering managers (Table 1). Our program distinction is the business courses, but we included our regular engineering technology courses for comparison. These courses collectively develop a robust toolkit of technical and soft skills crucial for Engineering Managers to effectively lead technical teams, projects, and organizations. The emphasis on applying knowledge to real-world problems, communicating with diverse stakeholders, thinking critically and ethically, and working collaboratively prepares students for the multifaceted challenges and opportunities they will face as Engineering Managers in industry. Graduates go to work in a wide variety of positions in technology-based companies, governmental agencies, non-profit organizations, and consulting firms. Engineering management master's programs boost careers by helping train students to solve complex problems by utilizing basic finance, accounting, economics, and risk analysis methods, providing competent leadership, and developing the skills and abilities of teams and individuals within a company, communicating effectively, and understanding the societal, ethical, cultural, legal, and political issues that are prevalent in today's global society.

TABLE 1. TECHNICAL AND SOFT SKILLS TAUGHT WITH IMPORTANCE TO ENGINEERING MANAGERS

Course	**Technical Skills**	**Soft Skills**	**Importance to Engineering Managers**
BCED 6820 Managerial Communication		Written and oral communication, teamwork, professionalism, interpersonal skills, conflict resolution, ethical communication	Enables effective communication, collaboration, and professional conduct essential for leadership roles
STAT 5140 Probabilistic & Statistical Reasoning	Statistical concepts and problem-solving	Communicating to diverse audiences, active participation, independent work, critical thinking, time management	Develops ability to communicate technical ideas, think critically, and manage time effectively
MGMT 6740 Leadership & Motivation	Leadership and motivation theories and strategies	Emotional intelligence, communication, conflict resolution, coaching and mentoring, change management	Equips managers to lead, inspire, and guide teams through challenges and change
ACTG 6100 Accounting and Legal Issues for Managers	Accounting principles and problem-solving	Communication, teamwork, professionalism, work ethic, critical thinking, ethical reasoning, time management, organization	Provides foundational business knowledge and cultivates professional skills for cross-functional collaboration and decision-making
BCED 6910 Internship Program		Professionalism, written and oral communication, critical thinking, reflection, networking, time management, responding to feedback	Offers immersive opportunities to develop and apply soft skills in real professional setting

Course	Technical Skills	Soft Skills	Importance to Engineering Managers
ET 6010 Safety Planning	Developing safety training programs, statistical analysis, accident investigation, risk assessment	Communication, critical thinking, problem-solving, collaboration	Prepares managers to effectively design, implement, and communicate safety programs and practices
ET 6300 PMI Project Management	Project management software and techniques, applying PM principles to real scenarios	Communication, leadership, teamwork, problem-solving, ethical decision-making	Develops skills to lead and deliver technical projects while considering broader impacts successfully
ET 6620 Methods of Research	Research design, data collection and analysis, scientific communication	Understanding research language, selecting appropriate methodologies, critical literature review, active engagement	Equips managers to conduct, interpret, and communicate research to drive evidence-based decisions and innovation
ET 6810 Engineering Management Theory and Application	Leadership, strategic planning, financial management, project management, operations and supply chain, marketing and sales, legal and ethical issues, product development, systems engineering, R&D management, sustainability	Critical thinking, communication, decision-making	Provides comprehensive knowledge and practical skills for effectively leading and managing technical organizations
ET 6870 Engineering Management	Project and program management concepts and techniques, process improvement, enterprise modeling	Planning, organizing, controlling, leading, communicating, decision-making, ethics	Develops technical and managerial capabilities to oversee projects, processes, and high-tech teams successfully
ET 6190 Six Sigma	Six Sigma methodology, DMAIC process, statistical tools, process improvement	Teamwork, collaboration, problem-solving, clear and evidence-based communication	Equips managers with a proven framework and techniques to drive quality, efficiency, and continuous improvement

Our program features a unique 250-hour advanced professional internship. Unlike other engineering programs, our internships are overseen by an industry supervisor and our business coordinator. Students must pay tuition and fees for this course, as the university provides administrative and academic support throughout the internship period. Most of our interns are offered paid internships, separate from the tuition costs of receiving academic credit. While most of our internships are local, some students have completed internships in different states and countries. This program allows students to earn graduate college credit and gain valuable experience in a job-related field within their area of concentration. The primary objectives of this internship course include the following:

- Assist students in understanding the chosen field of study's theory, principles, practices, and procedures.
- Help students assimilate and use the special knowledge, skills, and abilities previously studied in the classroom by performing duties and responsibilities related to the specific study area.
- Introduce students to the professional role of a practitioner in the selected field of study and encourage them to begin networking in the field.
- Acquaint students with the operation of business systems and related technology and how these systems enhance productivity and research.
- Help students recognize the value and importance of oral and written communication.
- Assist students in developing efficient, ethical, and accurate work habits.

In addition to completing their industry internship, students will finish the course with a digital portfolio. This portfolio analyzes their STEM and soft skills needed in the workplace. Various assignments engage writing, reflective, and oral presentation skills that make our students better prepared for the workforce. Components of the portfolio include weekly journals (22.5% of final grade), specialist interview summaries (2.5% of final grade), resume and application letters (15% of final grade), written report (10% of final grade), oral presentation (20% of final grade), and supervisor midterm and final evaluations (30 % of final grade).

The journal is a time for students to reflect on public information regarding duties performed throughout the week. It includes descriptions of knowledge, skills, and attitudes gained during that week's internship experience. Keeping a weekly journal has many benefits. First, it encourages regular reflection. Writing weekly journal entries forces you to pause each week and consciously think about what you are learning and gaining from experience. This can solidify the lessons learned. Second, it tracks growth over time. Looking back over several weeks of journal entries allows you to see how much you have progressed in gaining skills, knowledge, and understanding of your role. This helps highlight your development. Third, it documents learning. Having specific examples of activities performed, knowledge applied, and skills gained each week provides documentation you can refer back to. This also provides concrete examples you can draw from when building your resume or applying for jobs. Fourth, it prepares for performance reviews. Keeping thorough journal entries makes preparing for check-ins with your manager easier. You will have a log of achievements and learnings to reference rather than trying to recall from memory. Keeping a reflective journal supports your learning process, personal

development, and preparation for future career moves - all extremely valuable during an internship experience.

Each student must conduct a personal interview with a specialist in the engineering management field. These interviews can help someone's future career in several ways. First, specialist interviews help students to gain an insider perspective. Speaking to an expert in the field gives insider information on day-to-day responsibilities, challenges, and realities on the job. This can help someone determine if the career is indeed a good fit. Second, they help to explore new opportunities. Industry veterans know emerging roles, future trends, and gaps that may lead to new opportunities. Discussing these can reveal potential career paths one may not have previously considered. Third, they help to expand a student's professional network. Making a positive connection with an industry leader, even for an informational interview, grows one's professional network. Industry contacts provide advice, serve as potential mentors, and may aid future job search efforts. Fourth, they help to gather career advice. Those established in their field can provide guidance on sought-after skills, resume gaps that should be addressed, essential training/education, and other tips to help someone achieve their career goals. Fifth, interviews help to grow an understanding of the industry and its roles. Talking to a specialist provides a deeper understanding of typical career timelines, work environments, terminology, and the overall nature of specific roles within an industry. This context aids future career decisions. Specialist interviews equip someone exploring or pursuing an industry career with revelations and advice for mapping out a rewarding professional journey ahead. The insights and connections gained can prove invaluable for tuning one's career trajectory toward a fulfilling and successful path.

For many reasons, written reports and oral presentations are essential in the internship experience. These assignments help interns process and integrate what they learn from their hands-on experiences at the internship site. They force interns to organize their thoughts, analyze what they have learned, and articulate the knowledge and skills they have developed. They allow interns to connect their internship experiences back to theories and concepts from coursework. Making these connections helps solidify learning and shows how academic knowledge can be applied in real-world settings. They develop skills in reflection, writing, and public speaking that are invaluable for future careers. The ability to critically reflect, communicate ideas clearly in writing, and speak confidently to a group are sought-after abilities in nearly all fields. They provide valuable feedback for the internship site supervisor and faculty advisor on how effectively the interns learn and apply themselves. Presentations allow direct evaluation, while written reports allow more thorough assessment over time. In short, reflective writing and presentations hold interns accountable for integrating work experiences and academic knowledge while developing crucial soft skills. They transformed scattered daily experiences into consolidated, meaningful learning that equips interns for smooth transitions into future professional roles.

Supervisor mid-term and final evaluations benefit student interns and academic programs for several reasons, such as feedback for interns, program assessment, fulfillment of academic requirements, and improvement of future preparedness. The evaluations give interns constructive

feedback on strengths, weaknesses, and areas needing improvement from the expert perspective of an industry supervisor. This allows interns to capitalize on strengths and address growth areas. Evaluations enable academic programs to assess the effectiveness of curriculum alignment with industry needs. Trends in feedback can show knowledge/skill gaps that need to be addressed. Many academic programs require satisfactory supervisor ratings as part of internship course credit or cooperative education programs. The ratings provide documentation of completion. Intern host organizations provide a front-line perspective on the job readiness of graduates that academics cannot provide. Their input helps programs adapt. These midpoint and final evaluations support the continuous improvement of student interns and academic programs to maximize the value of experiential education. The feedback benefits all stakeholders.

In 2023, the MSPS program completed a review outlining its successes in enrollment, graduation, and employment rates. Here, we analyzed data collected by internship employers from the 2015-2023 academic years to investigate the impact of MSPS business education on students' work performance. Students then self-reported whether they had a job at graduation and what that salary was.

Materials and Methods

Our sample includes all MSPS students who completed an engineering management internship, a component of their degree requirements. This advanced professional internship is completed during the student's last or next to last semester of coursework. We had a total of 55 students from the fall of 2015 through the fall of 2023 semesters. First, to determine the impact of MSPS business education coursework on students' work performance, we utilized the final evaluation of student interns. This evaluation addressed many soft skills learned in the business core curriculum and STEM preparedness. Second, students self-reported whether they had a job at graduation and what that starting salary was during an exit interview with the program director, program graduate coordinator, and business coordinator.

Results and Discussion

The final evaluation was collected in the internship program course for 55 students completing engineering management internships. Section one looks at the intern's soft and hard skill evaluation compared to other employees or in accordance with the achievement objective. Categories are listed as excellent, good, average, below average, and poor. Section two looks at the specific interns' discipline question. All engineering management students are rated as better than new employees, equal to new employees, and less than new employees. The quantitative results for section one are shown in Table 2, and the results for section two are in Table 3.

TABLE 2. SECTION ONE OF INTERN EVALUATIONS

	Intern Final Evaluation Section One					
	Excellent	Good	Average	Below Average	Poor	Total # Students
Interpersonal Skills	41	14	0	0	0	55
Judgment	39	14	2	0	0	55
Punctuality	41	9	4	1	0	55
Dependability	42	11	2	0	0	55
Knowledge of Concentration Content	37	17	1	0	0	55
Attitude	48	7	0	0	0	55
Professional Appearance	42	13	0	0	0	55
Written Communication Skills	37	17	1	0	0	55
Oral Communication Skills	37	16	2	0	0	55
Problem-Solving Skills	40	14	1	0	0	55
Knowledge of Technology	35	19	1	0	0	55
Quality of Work	41	13	0	1	0	55
Responsibility	43	11	1	0	0	55
Initiative	45	9	0	1	0	55
Overall Performance	43	11	1	0	0	55

TABLE 3. SECTION TWO OF INTERN EVALUATIONS

	Intern Final Evaluation Section Two			
	Better Than	Equal To	Less Than	Total # Students
Ability to Utilize Problem-Solving skills in a real-world setting	48	7	0	55

In section one of the intern evaluation, students were consistently evaluated above average when looking at interpersonal skills, judgment, punctuality, dependability, knowledge of concentration content, attitude, professional appearance, written and oral communication skills, problem-solving skills, knowledge of technology, quality of work, responsibility, initiative, and overall performance when compared to other employees or in accordance with the achievement objective. Punctuality was our lowest category, with 90.91% scoring above average, and three categories (interpersonal skills, attitude, and professional appearance) scored 100% above average. All but one category was between 96.36% and 100% above average. In section two of the intern evaluations, 87.27% of our students were rated better than new employees in utilizing concentration-specific problem-solving skills in real-world settings.

The internship supervisor evaluations provide valuable insights into the performance and preparedness of MSPS engineering management student interns. The data indicates stellar achievement across all soft skills and attributes rated in Section 1. Between 96-100% of students scored "above average" or higher on qualities like communication, punctuality, problem-solving, and responsibility compared to benchmarks. Most impressively, 100% were evaluated as having excellent or good interpersonal abilities, attitudes, and professional appearance. The outstanding marks in soft skills confirm the significant impact of the MSPS program's business education components and training approaches. Students clearly demonstrate competence in the people skills, behaviors, and professional bearing that complements technical expertise.

Additionally, the high percentage of "above average" ratings in discipline-specific areas like judgment, content knowledge, use of technology, and quality of work showcase how students apply scientific mastery. While further comparison of average rubric scores over time could indicate any curriculum gaps to improve, the current strong results verify students' readiness to leverage MSPS science specializations effectively in workplace settings. Overall, at least 96% of scores surpassed expectations in all but one area, pointing to widespread proficiency in both integrating technical abilities and exhibiting intangible workplace behaviors critical for early career success.

Moreover, 87% of students rated as better than new hires in utilizing problem-solving competencies have significant implications. Given that problem-solving is a hallmark analytical skill in engineering management, outperforming entry-level peers exhibits attained sophistication. This confirms that the curriculum and experiential combination cement scientific foundations and develop advanced critical thinking abilities. Being able to exercise adept problem-solving techniques to inform data-driven decisions is invaluable for process improvement roles graduates often assume.

These extremely positive student achievement results provide quantitative evidence that MSPS engineering management graduates enter the workforce primed for early impact. Their well-roundedness in applying scientific expertise and leveraging "soft" attributes positions graduates to thrive in technical business contexts, all while outpacing peers. The multifaceted competency development verifies the curriculum's effectiveness for in-demand STEM talent. Ongoing tracking of indicators like employer ratings can guide any necessary adjustments to continue upholding graduate quality and workforce relevance. However, the present data affirms the program's success in building the complete package of knowledge, abilities, and skills that employers now expect in technical master's degree holders ready to contribute on day one.

During each student's exit interview after completing their internship, 90% of our students self-reported that they had a job at the time of graduation. Over 70% of our students were offered a job at the place of their internship. The other 20% either received a promotion at their current place of employment or were offered a position at a different company of the internship.

Conclusion

In conclusion, an analysis of internship supervisor evaluations confirms that the MSPS program in Engineering Management successfully equips students with the complex knowledge and

competencies that are now expected of technical graduates. Results showcase students' proficiency in integrating specialized scientific expertise with critical "soft" skills like communication, problem-solving, and professionalism.

Specifically, 96-100% of student interns were rated "above average" or higher across all soft skill attributes, directly validating the impact of extensive business skills training incorporated into the curriculum. Furthermore, 87% outperformed entry-level peers in applying analytical abilities, exemplifying attained sophistication. These exceptional results align with recent research advocating the expanded development of versatile competencies through interdisciplinary coursework and experiential learning.

The MSPS program produces exceptionally well-rounded graduates ready to meet current industry demands. The ongoing gathering of quantitative stakeholder feedback provides insight to guide continuous quality refinement. However, current achievement benchmarks quantify the success of an educational model that systematically cultivates scientific mastery alongside crossover abilities for early career impact. Graduates' multilayered preparation enriches individual employability and elevates wider STEM talent development. Ultimately, the MSPS program's effectiveness confirms the value of evidence-based efforts to strengthen holistic graduate capability-building within PSM education.

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