The Impact of NACE Competency Integration on Students' Perceived Career Readiness in Construction Management Education

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Abstract
This study investigates the integration of NACE Career Readiness Competencies into a construction management curriculum and its effectiveness in fostering students' professional growth. Using a survey-based approach, changes in students' self-perceived competencies were assessed across nine Course Learning Outcomes (CLOs) and eight NACE competencies before and after completing a junior-level course. The results revealed significant improvements in all CLOs, as demonstrated by the Wilcoxon Signed-Rank test, with Critical Thinking exhibiting the highest perceived growth and large effect sizes across all outcomes. A Friedman test indicated significant variability in perceived growth among the NACE competencies, with Critical Thinking ranked highest, while Global Fluency and Career Development ranked lowest. Post-hoc analysis further highlighted substantial differences in growth across competencies, reflecting the uneven emphasis within the course curriculum. These findings underscore the effectiveness of competency-based education in enhancing technical and cognitive skills while identifying gaps in global and career-oriented competencies. This result highlighted the importance of incorporating global studies, cross-cultural collaboration projects, and structured career readiness programs within the course curriculum. This study contributes to the growing body of research on competency-based education by providing evidence of its effectiveness in fostering critical professional skills and offering actionable insights for enhancing curriculum design to prepare students for a dynamic and interconnected workforce.

Key Words: NACE Competencies, Construction Education, Career Readiness

Introduction

Competency-based education has gained significant traction in recent years, particularly in higher education, where institutions are seeking to better align academic programs with the skills and competencies demanded by employers. Competency-based education (CBE) is an approach that shifts the focus from time-based learning (e.g., completing a course in a set number of weeks) to learning outcomes. In CBE, students progress by demonstrating mastery of specific skills or competencies. This approach is particularly relevant in today’s rapidly changing job market, where employers value practical skills and adaptability as much as academic knowledge. One of the most recognized frameworks for these competencies is provided by the National Association of Colleges and Employers (NACE), which identifies a set of core competencies that are critical for career readiness [1].

The NACE competencies were developed to address the skills gap that often exists between what students learn in the classroom and what employers expect from new graduates entering the workforce. These competencies are intended to complement traditional academic knowledge by focusing on professional and interpersonal skills that are essential for workplace success. The key NACE competencies include Critical Thinking and Problem Solving, Oral and Written Communication, Teamwork and Collaboration, Digital Technology, Leadership, Professionalism and Work Ethic, Career Management, and Global/Intercultural Fluency [2].

By integrating competencies like those defined by NACE into course objectives, educators aim to ensure that students not only acquire knowledge but also develop practical skills that will enhance their employability. The NACE competencies provide a structured way for educators to assess and improve students' preparedness for the workforce while also helping students recognize their growth in these essential areas. Higher education is attempting to equip students for careers by developing generic competencies necessary for their future careers [3]. NACE Career Readiness Competencies have been adopted by several higher education institutions in the United States. However, the incorporation of these competencies in the course learning outcomes is very important, and it is directly dependent on the course syllabus developed by the instructor. Research has shown that meeting these competencies increases the chance of employment for students [4]. Therefore, the generic course-related skills should be strengthened with occupation-specific skills by framing those skills within the objectives of a course.

Literature Review

Previous research in competency-based education (CBE) has primarily focused on its effectiveness in enhancing student outcomes, such as academic performance, skill mastery, and employability. Studies have shown that integrating competencies like those from the NACE framework into curricula can improve students' preparedness for the workforce [5]. However, most of this research emphasizes objective measures of success (e.g., job placement rates, employer feedback) rather than student perceptions. The implementation of NACE competencies in construction and architectural engineering education has gained attention as educators aim to prepare career-ready graduates equipped with essential skills. Goodarzi [1] explored the incorporation of NACE competencies into the LEED Lab, which was offered in a construction management program. The study highlighted how experiential learning through sustainability projects provided students with hands-on opportunities to develop competencies critical for the green building industry. Specific course outcomes were aligned with NACE competencies, and additional learning objectives were introduced to address gaps, ensuring a more comprehensive competency development approach. However, this study did not evaluate the students’ perceived growth as a result of this implementation.

Walters [6] investigated the integration of NACE competencies in architectural engineering curricula, focusing on aligning core competencies with ABET standards and program educational outcomes. The study utilized a systematic framework to map course objectives with NACE competencies. Their study included assessments of student self-reflections and professional interactions to measure competency development. Another study by Garshasby et al. [7] explored students' perceptions of the design-build educational delivery method within a construction management curriculum. The study highlighted that students generally viewed this approach positively, emphasizing its effectiveness in enhancing practical skills, teamwork, and project-based learning outcomes. Some studies have examined how CBE impacts specific competencies, such as communication and teamwork, but few have explored students' self-assessed growth in these competencies across a wide range of courses. Overall, research on student perceptions about competency growth is limited, often focusing on specific fields such as medicine [8]–[10] rather than providing a broader view applicable to various academic disciplines.

The integration of artificial intelligence (AI) into CBE has gained significant attention in recent years, offering new methodologies for curriculum development, assessment, and personalized learning. AI-driven approaches, including generative AI and machine learning, are reshaping curriculum design by providing adaptive learning pathways and real-time adjustments to educational materials, ensuring alignment with industry demands and evolving technological landscapes. Several studies have focused on the role of AI in improving CBE [11]–[13]. However, challenges remain, particularly in balancing AI's potential with ethical considerations, including data privacy, bias mitigation, and the need for human oversight in decision-making. Moreover, the impacts of these advancements in improving the students' readiness for a career have not yet been evaluated.

As pointed out, while there is a growing body of literature on competency-based education and its impact on student outcomes, there is limited research specifically addressing Architecture, Engineering, and Construction (AEC) student perceptions of their growth in competencies as a result of curriculum integration. Most existing studies focus on the effectiveness of CBE from the perspective of employers or academic performance metrics, leaving a gap in understanding how students themselves perceive their development in these areas. This research aims to fill that gap by directly surveying students who have participated in courses that integrate NACE competencies in their course objectives. By focusing on student perceptions, this study will provide valuable insights into how students view their competency growth, which can inform future curriculum design and teaching practices.

Method

The purpose of the study is to analyze how students' perceptions of their competencies change after participating in a course that integrates NACE competencies. This study employs a quasi-experimental design with a quantitative methodology to systematically analyze how students' perceptions of their competencies change after participating in a course that integrates NACE competencies. A pre-test/post-test approach is used to measure students' self-reported competency growth, allowing for a structured comparison of competency levels before and after the intervention. Given that the study is conducted within an existing course and does not involve random assignment of participants, the quasi-experimental approach is the most appropriate method for evaluating the impact of integrating NACE competencies in a real-world educational setting.

Data Collection

A structured survey was used to quantitatively measure student perceptions of competency growth after participating in the Construction Cost Estimating course, which explicitly integrates NACE competencies into its curriculum. The survey was designed to evaluate the effectiveness of the course in achieving its CLOs and fostering the targeted NACE competencies through structured assignments and instructional activities. The survey included three sections:

1. Demographic Information: Age, gender, year in the program, prior construction experience, and familiarity with cost estimating.

2. Pre- and Post-Semester Perceived Competency: Students assessed their competency levels for each CLO at the beginning and end of the semester using a five-point Likert scale (1 = No competency, 5 = High competency).
3. NACE Competency Growth Perception: Students ranked their perceived growth across eight NACE competencies, from 1 (greatest growth) to 8 (least growth), based on their learning experience in the course.

Following approval from the Institutional Review Board (IRB #2231878-1), the survey was administered to junior-level students enrolled in the Construction Cost Estimating course in the Fall 2024 semester at Ball State University. Participation was voluntary, and students had the option to withdraw at any time without penalty. The survey was anonymous, ensuring no personally identifiable information was collected.

Data Analysis

To assess changes in students' perceived competencies, descriptive and inferential statistical analyses were conducted:

1. Demographic and Descriptive Analysis: The demographic profile of respondents was summarized using descriptive statistics.
2. Competency Growth Analysis: A paired t-test was initially considered to compare pre- and post-semester competency scores. However, as normality is a key assumption for the paired t-test, a Shapiro-Wilk test was conducted to determine whether the data met this assumption. If normality was violated, a non-parametric alternative (Wilcoxon Signed-Rank test) was used.
3. NACE Competency Ranking Analysis: A Friedman test was performed to evaluate students' ranked perceptions of their competency growth across the eight NACE competencies.

Results

Respondents profile

A total of 67 students participated in the survey. However, after cleaning the data by excluding the incomplete responses, 60 responses were retained for analysis. The data was then coded numerically for statistical analysis. The demographic characteristics of the survey respondents are presented in Table 1. A total of 60 participants completed the survey. The majority of respondents (95%) were between the ages of 20 and 25, while 3.3% were over the age of 25, and 1.7% were under the age of 20.

The sample was predominantly male, with 70% identifying as male, 28.3% identifying as female, and 1.7% identifying as non-binary or third gender. In terms of academic standing, 68.3% of the respondents were seniors, while 31.7% were juniors. No participants identified as freshmen or sophomores. These demographic results indicate that the sample primarily consisted of upperclassmen (juniors and seniors) and was predominantly male.

Table 1. Respondents demographics

Age	Frequency	Percent
Under 20	1	1.7
20-25	57	95
Over 20	2	3.3
Total	60	100
Gender	**Frequency**	**Percent**
Male	42	70
Female	17	28.3
Non-binary/third gender	1	1.7
Total	60	100
Year in the program	**Frequency**	**Percent**
Freshman	0	0
Sophomore	0	0
Junior	19	31.7
Senior	41	68.3
Total	60	100

Evaluation of the student competency changes in CLOs

In order to determine a suitable method for the comparison of pre and post-course competency of students regarding the CLOs, a normality test of Shapiro-Wilk was first conducted. In this test, the null hypothesis is that the data is normally distributed, and the alternative hypothesis is that the data is not normally distributed. The results, as shown in Table 2, showed that the data rejected the null hypothesis (pValue < 0.05), thus indicating that the data does not follow the normal distribution.

Table 2. Test of Normality (Shapiro-Wilk)

			W	p
Start-CLO1	-	End-CLO1	0.855	< .001
Start-CLO2	-	End-CLO2	0.890	< .001
Start-CLO3	-	End-CLO3	0.895	< .001
Start-CLO4	-	End-CLO4	0.897	< .001
Start-CLO5	-	End-CLO5	0.893	< .001
Start-CLO6	-	End-CLO6	0.884	< .001
Start-CLO7	-	End-CLO7	0.885	< .001
Start-CLO8	-	End-CLO8	0.859	< .001
Start-CLO9	-	End-CLO9	0.868	< .001

Note. Significant results suggest a deviation from normality.

Since the Shapiro-Wilk normality test indicated a violation of the assumption of normality for the Paired Samples T-test, an alternative non-parametric test was required to analyze the data accurately. As a result, a Wilcoxon Signed-Rank Test was conducted to compare students' self-evaluated competency at the start and end of the semester for each course learning outcome (CLO). The results, as indicated in Table 3, indicated a statistically significant increase in competency for all CLOs from the start to the end of the semester.

Table 3. Wilcoxon Signed-Rank Test

Measure 1		Measure 2	W	z	p	VS-MPR*	Rank-Biserial Correlation	SE Rank-Biserial Correlation
Start-CLO1	-	End-CLO1	104	-5.661	< .001	$5.218\times10^{+6}$	-0.87	0.152
Start-CLO2	-	End-CLO2	12.5	-6.161	< .001	$1.152\times10^{+8}$	-0.982	0.158
Start-CLO3	-	End-CLO3	0	-6.275	< .001	$1.944\times10^{+8}$	-1	0.158
Start-CLO4	-	End-CLO4	0	-6.093	< .001	$6.021\times10^{+7}$	-1	0.163
Start-CLO5	-	End-CLO5	13.5	-6.088	< .001	$6.263\times10^{+7}$	-0.98	0.16
Start-CLO6	-	End-CLO6	15	-6.201	< .001	$1.510\times10^{+8}$	-0.979	0.157
Start-CLO7	-	End-CLO7	16	-6.065	< .001	$7.769\times10^{+7}$	-0.976	0.16
Start-CLO8	-	End-CLO8	0	-5.968	< .001	$4.120\times10^{+7}$	-1	0.166
Start-CLO9	-	End-CLO9	0	-6.093	< .001	$7.973\times10^{+7}$	-1	0.163

Note. For all tests, the alternative hypothesis specifies that Measure 1 is less than Measure 2. For example, Start-CLO1 is less than End-CLO1.

* Vovk-Sellke Maximum *p* -Ratio: Based on a two-sided *p-value*, the maximum possible odds in favor of H_1 over H_0 equals $1/(-e\ p\log(p))$ for $p \leq .37$ (Sellke, Bayarri, & Berger, 2001).

For all comparisons, the Wilcoxon Signed-Rank test yielded significant results with W values ranging from 0 to 104 and z-scores between -5.661 and -6.275, all with p<.001. The rank-biserial correlation coefficients ranged from -0.87 to -1.00, indicating strong effect sizes, with standard errors (SE) ranging between 0.152 and 0.166.

The Vovk-Sellke Maximum p-Ratios (VS-MPR), which represent the maximum possible odds in favor of the alternative hypothesis over the null, ranged from 5.218×10^6 to 1.944×10^8, further confirming the strength of the statistical evidence supporting increased competency levels. These results suggest a significant improvement in students' self-assessed competencies across all CLOs over the course of the semester.

NACE Competency growth

A Friedman test was conducted to assess differences in students' perceived growth across eight NACE competencies. Participants (N = 60) ranked each competency based on their perceived growth, with 1 indicating the highest perceived growth and 8 the lowest. The descriptive statistics results are presented in Table 4.

Table 4. Descriptives

NACE Ranking	N	Mean	SD	SE	Coefficient of variation
Critical Thinking	60	2.450	1.799	0.232	0.734
Communication	60	4.367	2.017	0.260	0.462
Teamwork	60	3.333	1.963	0.253	0.589
Technology	60	4.117	1.869	0.241	0.454
Leadership	60	4.350	2.169	0.280	0.499
Professionalism	60	4.950	1.692	0.218	0.342
Career Development	60	5.717	1.823	0.235	0.319
Global Fluency	60	6.717	2.148	0.277	0.320

The results show that Critical Thinking had the lowest mean rank (2.45), suggesting it was perceived as the area with the highest growth, followed by Teamwork and Technology. Global Fluency had the highest mean rank (6.72), indicating the least perceived growth.
The coefficient of variation ranged from 0.319 to 0.734, indicating varying levels of consistency in how participants rated their growth across the competencies, with the greatest variability observed for Critical Thinking and the least for Career Development**.**
A Friedman test was conducted to examine whether there were significant differences in students' perceived growth across the eight NACE competencies. The results, as presented in Table 5, show that the test was statistically significant, $X^2(7)=123.472$, $p<.001$, supporting the results of the descriptive statistics indicating that students ranked their growth in these competencies differently.

Table 5. Friedman Test

Factor	X^2_F	df	p	Kendall's W
NACE Ranking	123.472	7	< .001	0.294

The effect size, measured by Kendall's W, was W=0.294, suggesting a moderate level of agreement among the rankings. This result indicates that while there were significant differences in perceived growth among the competencies, the level of consensus among students was moderate. These findings suggest that students experienced varying levels of perceived growth in different competencies, with some competencies being rated as contributing more to their development through the course.

A Conover's post-hoc test was conducted following a significant Friedman test to determine pairwise differences in students' perceived growth across the NACE competencies. The results indicated multiple statistically significant differences after applying Bonferroni and Holm corrections for multiple comparisons. The results are shown in Table 6.

Table 6. Conover's Post Hoc Comparisons - NACE Ranking

		T-Stat	df	W_i	W_j	r_{rb}	p	p_{bonf}	p_{holm}
CritThk	Comm	5.058	413	147.000	262.000	-0.681	< .001	< .001	< .001
	TeamW	2.331	413	147.000	200.000	-0.372	0.020	0.566	0.182
	Tech	4.398	413	147.000	247.000	-0.644	< .001	< .001	< .001
	Lead.	5.014	413	147.000	261.000	-0.574	< .001	< .001	< .001
	Prof.	6.597	413	147.000	297.000	-0.807	< .001	< .001	< .001
	Career	8.620	413	147.000	343.000	-0.842	< .001	< .001	< .001
	Global	11.259	413	147.000	403.000	-0.903	< .001	< .001	< .001
Comm	TeamW	2.727	413	262.000	200.000	0.368	0.007	0.187	0.080
	Tech	0.660	413	262.000	247.000	0.063	0.510	1.000	1.000
	Lead.	0.044	413	262.000	261.000	0.004	0.965	1.000	1.000
	Prof.	1.539	413	262.000	297.000	-0.228	0.124	1.000	0.571
	Career	3.563	413	262.000	343.000	-0.474	< .001	0.011	0.005
	Global	6.201	413	262.000	403.000	-0.702	< .001	< .001	< .001

Table 6. Conover's Post Hoc Comparisons - NACE Ranking

		T-Stat	df	W_i	W_j	r_{rb}	p	p_{bonf}	p_{holm}
TeamW	Tech	2.067	413	200.000	247.000	-0.287	0.039	1.000	0.275
	Lead.	2.683	413	200.000	261.000	-0.355	0.008	0.213	0.084
	Prof.	4.266	413	200.000	297.000	-0.672	< .001	< .001	< .001
	Career	6.289	413	200.000	343.000	-0.737	< .001	< .001	< .001
	Global	8.928	413	200.000	403.000	-0.775	< .001	< .001	< .001
Tech	Lead.	0.616	413	247.000	261.000	-0.115	0.538	1.000	1.000
	Prof.	2.199	413	247.000	297.000	-0.320	0.028	0.796	0.227
	Career	4.222	413	247.000	343.000	-0.544	< .001	< .001	< .001
	Global	6.861	413	247.000	403.000	-0.755	< .001	< .001	< .001
Lead.	Prof.	1.583	413	261.000	297.000	-0.230	0.114	1.000	0.571
	Career	3.607	413	261.000	343.000	-0.441	< .001	0.010	0.005
	Global	6.245	413	261.000	403.000	-0.736	< .001	< .001	< .001
Prof.	Career	2.023	413	297.000	343.000	-0.358	0.044	1.000	0.275
	Global	4.662	413	297.000	403.000	-0.540	< .001	< .001	< .001
Career	Global	2.639	413	343.000	403.000	-0.462	0.009	0.242	0.086

Note. Grouped by subject.

Note. Rank-biserial correlation based on individual signed-rank tests.

According to Conover’s post-hoc test, Critical Thinking was ranked significantly higher in perceived growth compared to Communication (T=5.058,p<.001,rrb=−0.681), Technology (T=4.398,p<.001,rrb=−0.644T), Leadership (T=5.014,p<.001,rrb=−0.574T), Professionalism (T=6.597,p<.001,rrb=−0.807), Career Development (T=8.620,p<.001,rrb=−0.842), and Global Fluency (T=11.259,p<.001,rrb=−0.903). The difference between Critical Thinking and Teamwork was also significant before correction (T=2.331, p=.020T = 2.331) but not after Bonferroni and Holm adjustments.

Communication was ranked significantly higher in perceived growth compared to Career Development (T=3.563,p<.001,rrb=−0.474) and Global Fluency (T=6.201,p<.001,rrb=−0.702). Similarly, Teamwork showed significantly greater perceived growth than Professionalism (T=4.266,p<.001,rrb=−0.672), Career Development (T=6.289,p<.001,rrb=−0.737), and Global Fluency (T=8.928,p<.001,rrb=−0.775).

Technology showed significantly greater perceived growth than Career Development (T=4.222,p<.001,rrb=−0.544) and Global Fluency (T=6.861,p<.001,rrb=−0.755). Leadership also showed significantly higher rankings than Career Development (T=3.607,p<.001,rrb=−0.441) and Global Fluency (T=6.245,p<.001,rrb=−0.736). Finally, Professionalism was ranked significantly higher in perceived growth compared to Global Fluency (T=4.662,p<.001,rrb=−0.540). Career Development also differed significantly from Global Fluency (T=2.639,p=.009,rrb=−0.462).

Effect sizes (rank-biserial correlation) ranged from -0.681 to -0.903, indicating moderate to large differences where statistically significant. These results suggest that Critical Thinking was perceived as the area of greatest growth, while Global Fluency was perceived as contributing the least growth during the course.

Discussion

The findings of this study demonstrate a significant perceived growth in students' competencies after participating in a course that intentionally integrated the NACE Career Readiness Competencies. The consistent improvement across all measured Course Learning Outcomes (CLOs) aligns with previous research demonstrating the effectiveness of competency-based instructional design in higher education [1], [6]. This study reinforces the premise that embedding structured competency frameworks into course curricula can significantly enhance students' professional skill development. However, the variability in the magnitude of perceived growth across competencies warrants further examination and provides insights for refining educational approaches.

The statistically significant improvements observed across all CLOs, as indicated by the Wilcoxon Signed-Rank test, reflect a substantial impact on students' self-assessed competencies. The large effect sizes (rank-biserial correlations ranging from -0.87 to -1.00) provide strong empirical support for the course's effectiveness in fostering professional skills. These findings resonate with previous studies that highlight the advantages of competency-based education (CBE) in preparing students for the workforce by emphasizing both technical and soft skills [5], [6]. Additionally, these results add to the body of literature suggesting that competency integration enhances student engagement and perceived employability, as seen in other disciplines such as STEM and medical education [8], [9].

Critical Thinking was consistently ranked as the area with the most significant growth among the NACE competencies. This outcome reflects the course's emphasis on problem-solving, analytical reasoning, and decision-making, core elements embedded throughout the course activities and assessments. The prominence of this competency underscores the value of experiential and applied learning environments where students engage with real-world scenarios requiring critical analysis. However, the high perceived growth in Critical Thinking, compared to other competencies, also suggests the possibility of disproportionate emphasis on cognitive skills over other equally critical workforce competencies, such as communication and career management. While analytical skills are fundamental to construction management, a more balanced competency integration across the curriculum could ensure broader professional development.

In contrast, Global Fluency and Career Development were consistently ranked lower in perceived growth. This finding may indicate insufficient curricular emphasis on global perspectives and career readiness activities compared to technical skill development. The limited growth in Global Fluency is particularly significant given the increasing globalization of the construction industry, where cross-cultural collaboration and inclusivity play a vital role in project success. The lower ranking of Career Development suggests that while the course effectively supported technical and problem-solving competencies, there may be opportunities to further integrate professional preparation elements such as career planning workshops, mentorship programs, and networking opportunities with industry professionals. Addressing these gaps could foster a more holistic approach to career readiness.

The Friedman test confirmed significant differences in how students perceived growth across the eight NACE competencies, with a moderate effect size (Kendall's W = 0.294). This moderate consensus suggests variability in how students experienced growth across competencies, likely reflecting differences in instructional emphasis and individual learning experiences.
The post-hoc analysis revealed that Critical Thinking was perceived as contributing significantly more to growth than competencies such as Communication, Technology, Leadership, Professionalism, and Career Development. This differential growth highlights the importance of instructional balance when integrating professional competencies. Overemphasizing specific competencies while neglecting others could limit the comprehensive development needed for career readiness.

While the course effectively fostered cognitive and collaborative skills, additional emphasis on global awareness, cross-cultural communication, and career preparation strategies may be necessary for a more balanced development of workforce competencies. Incorporating guest lectures from industry professionals, global project case studies, and career development workshops could address these gaps.

Conclusion

This study reinforces the effectiveness of competency-based education in promoting significant growth in students' professional skills, particularly in Critical Thinking. However, the findings also highlight disparities in perceived growth across competencies, emphasizing the need for a more balanced curriculum that equally addresses cognitive, professional, and global competencies. By refining instructional strategies to include a broader range of professional development activities, educational programs can better prepare students for the diverse challenges of the modern workforce. Continued research into competency-based education across multiple contexts will further inform best practices for fostering career readiness among students.

While the study provides valuable insights into perceived competency growth, it is important to acknowledge limitations. The reliance on self-reported data introduces potential biases, as students' perceptions may not fully align with objective skill assessments. Additionally, the study focused on a single course within a specific program, limiting the generalizability of the results to other contexts. Future research could explore longitudinal assessments to track competency development over multiple courses or academic years. Additionally, incorporating a mixed-methods approach, including qualitative interviews and direct competency assessments, could provide a more comprehensive understanding of students' growth and the instructional strategies contributing to it.

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