Paper ID #51022

Engineering Student Interest and Confidence in Experimentation: A Comparative Study Across Academic Ranks

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Abstract
Innovation is an important skill for engineers. Previous research has identified experimentation as a key component of innovation. In this research, we explore engineering students' confidence in experimenting to understand how things work, as well as their interest in experimenting to find new ideas. We compare these attributes across students of different academic ranks (e.g., first-year versus seniors) and course contexts. Surveys were administered at the beginning and end of four engineering courses at a large public institution from Fall 2023 to Spring 2025. These surveys included seven-point Likert-type items validated in prior published research to measure innovation self-efficacy and innovation-related interests, with single items measuring experimentation confidence and interest. Our results show that students' confidence in their experimentation abilities was more variable than their interest in experimentation (confidence average ranged from 4.0 to 5.8 across classes, while interest averaged from 5.3 to 5.9). Notably, first-year students reported fairly high confidence in their experimentation abilities at the beginning of the second semester, exceeding that of upper-level environmental engineering students entering their junior year. Across many courses, confidence in experimentation increased from pre- to post-assessment, whereas interest levels remained generally stable. Experimentation confidence was moderately or weakly correlated with experimentation interest among students in these courses. Overall, engineering students' interest in experimentation remained high and stable, while confidence seemed to fluctuate. It is notable that the two items relate to different sub-types of experimentation. Future qualitative research could help explain the quantitative findings.

Keywords: Experimentation confidence, experimentation interest, innovation self-efficacy

Introduction
Innovation is an important skill in engineering [1]. The American Society of Civil Engineers (ASCE) recognizes innovation among the professional responsibilities of civil engineers and an important requisite to help develop sustainable solutions to challenges facing society [2]. Experimentation can play an important role in innovation [3]. In Dyer et al.'s [4] research, experimentation was identified among the behaviors that contributed to an innovative entrepreneur generating a novel business idea. More specifically, the "frequency with which they experiment in and explore the world with a hypothesis-testing mindset: visiting new places, trying new things, seeking new information, and experimenting to learn new things, as experimenters constantly explore the world intellectually and experientially, holding convictions at bay, testing hypotheses along the way." This is a somewhat broader conceptualization of experimentation compared to what is often applied in engineering.

Engineering accreditation requirements and bodies of knowledge recognize the importance of experimentation. The ABET EAC criterion 3 outcome 6 requires that graduates have "an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions" [5]. This is similar to the 'experimental methods and data analysis' outcome in the ASCE Body of Knowledge [2]. Traditional laboratories integrated into courses may fail to teach students about experimentation. These labs, such as in physics and chemistry, often have students following “recipes” where students are intended to “discover” pre-determined outcomes [6],[7]. In contrast, laboratories can employ inquiry or discovery practices that are more aligned with true experimentation of the type linked to innovation [8],[9].

In engineering, “experimentation” extends beyond hypothesis testing and includes multiple forms of learning-oriented testing embedded within design and development projects. Zwart [10] proposes a typology of engineering laboratory experiments based on thick descriptions of engineering projects, distinguishing experiments that test (e.g., hypotheses, designs, means–end knowledge, and models/software) from experiments that determine (e.g., working principles, preferred actions, and values or relationships among variables), as well as a trial-and-error form of exploration. Although Zwart’s typology focuses on laboratory experiments and explicitly excludes pure computer simulations and thought experiments, it provides a useful anchor for characterizing the different purposes of experimentation that students may encounter in engineering curricula.

Building on this broader view, prototyping in engineering design can be understood as a form of experimentation because it produces evidence that answers design questions (e.g., whether a concept works, how performance changes across conditions, and what modifications improve function). Prototyping enables students to explore and iterate on creative ideas by making concepts tangible, varying design features, and observing performance and user-interaction outcomes [11],[12],[13],[14]. Prototypes, therefore, function as experimental artifacts that support learning, exploration, refinement, and decision-making across the design process, rather than serving only as a final verification step. Consistent with this framing, prototyping experiences have been associated with increases in students’ creativity and innovation-related outcomes, reinforcing experimentation—broadly construed—as a key mechanism linking engineering design practice to innovation development.

To support the interpretation of experimentation experiences across course contexts, we synthesize prior typology work into a concise set of experiment types (Table 1), which is used as an analytic lens for describing course activities and later interpreting survey results.

Table 1. Experimentation types

Type # / Title	**Working Description**	**Closest Zwart [10] ideal type(s)**
1. Explanatory / hypothesis-testing	Tests relationships to explain “how things work” (mechanisms; variable relationships; descriptive outcomes).	Hypothesis testing (Boyle)
2. Design / prototype testing	Tests whether a prototype/system meets requirements; performance verification; often design-guiding.	Design testing (Wright Flyer)
3. Working principle / proof-of-concept	Establishes whether a proposed mechanism or principle can work; precedes or guides design refinement.	Working principle (Edison filament)
4. Comparative / intervention (“what works best”)	Compares alternatives/configurations/interventions to determine preferred approach; includes user/customer comparisons when framed as comparing interventions.	Preferred actions (Swan/Raven)
5. Parameter & relationship determination	Determines parameter values or empirical relationships needed for design decisions or characterization (e.g., calibration curves, treatability performance, measured relationships).	Values/relations (Stress/strain + Torquay)

Type # / Title	Working Description	Closest Zwart [10] ideal type(s)
6. Means–end method validation	Validates whether a general method/procedure reliably achieves a technical end (method-level validation; more general than a single design).	Means–end knowledge testing (Greyhound)
7. Model/software validation	Tests/validates simulation or software outputs against empirical measurements for a specific application.	Model/software testing (AlphaZero)
8. Exploratory trial-and-error	Early exploration to "get a grip," identify constraints/variables, and learn what not to do; often precedes well-formed tests.	Trial-and-error exploration

It is also important to note that experimentation is not new to many students entering engineering programs. Innovation-relevant practices, including experimentation, are embedded within the Next Generation Science Standards (NGSS), which emphasize science and engineering practices such as asking questions and defining problems, and planning and carrying out investigations [15]. These practices frame experimentation as an integral component of scientific inquiry and engineering design, involving observation, data collection, and evidence-based reasoning rather than isolated laboratory skills. Prior research suggests that certain high school STEM curricular experiences can foster creative thinking (e.g., [16]). As a result, students may enter undergraduate engineering with prior exposure to experimentation and with varying levels of confidence and interest in engaging in experimental activities.

The theoretical grounding for this study draws on Expectancy–Value Theory (EVT) [17] and Social Cognitive Career Theory (SCCT) [18], both of which conceptualize self-efficacy and interest as distinct but related motivational constructs. Prior research in engineering education by Schar et al. [19] found positive relationships between innovation self-efficacy and innovation interest. Importantly, self-efficacy reflects individuals' confidence in their ability to perform a task and does not necessarily correspond to their actual level of skill.

Research Questions
This research aims to answer the following research questions:

RQ1. How do students' experimentation self-efficacy and interest related to innovation vary among academic ranks?

RQ2. Do students change in their experimentation self-efficacy and interest related to innovation across a semester, which includes at least one course that embeds open-ended projects?

RQ3. To what extent are students' innovation-related experimentation self-efficacy correlated with their experimentation interests?

Methods

Setting

This research was conducted at a single large, public institution that offers multiple ABET-accredited undergraduate engineering degree programs (University of Colorado Boulder IRB Protocol #23-0388). A convenience sample of five courses that embedded open-ended projects was selected for inclusion in the study; four of these courses were taught by the first author. These courses spanned semesters 2 through 8 (assuming students enrolled when intended in the curriculum) and represented a range of instructional contexts. Within each course, experimentation was embedded in different ways and served different purposes. Table 2 lists the five courses and maps course activities to the different types of experimentation characterized in Table 1. This experimentation-type mapping was developed to characterize instructional contexts for analysis and was not used as a criterion for course selection. The courses are described below in approximate curricular order, beginning with first-year design, followed by an innovation-focused junior-level course, and then a sequence of upper-division environmental engineering (EnvE) courses.

Table 2. Dominant (D) and secondary (S) experimentation types embedded within each course

Experiment Type	FY Projects	Inv& Innov	EnvE WChem	EnvE Fate & Trans	EnvE Capstone
1. Explanatory / hypothesis-testing	—	—	D	D	—
2. Design / prototype testing	D	D	S	D	S
3. Working principle / proof-of-concept	S	D	S	S	S
4. Comparative / intervention	S	D	S	D	D
5. Parameter & relationship determination	D	S	D	D	D
6. Means–end method validation	—	—	—	D	D
7. Model / software validation	—	—	—	—	S
8. Exploratory trial-and-error	D	D	S	S	S

The **First-Year (FY) Projects** course is required for most engineering majors and typically offers ~14 sections in both fall and spring semesters. The course includes learning objectives related to design, teamwork, communication, and ethics. In the section of interest, students completed a two-week introductory project focused on creating team nameplates using basic electronics, which emphasized exploratory trial-and-error and early proof-of-concept work. This was followed by a ten-week main project on a variety of topics, primarily initiated by the students, including the design of a ski helmet concussion sensor, speed-bump energy harvesting, and a ski lift winch. These team-based projects involved iterative prototyping and testing to evaluate design performance, compare alternatives, and refine working principles through evidence generated during testing and analysis. Note that first-year engineering students in most majors are also required to take natural science courses with laboratories (e.g., chemistry and physics), which may further shape their prior experiences and confidence related to experimentation.

The junior-level **Invention and Innovation (Inv&Innov)** course is part of an interdisciplinary engineering major that requires a project-based course each year, creating a strong expectation that design work includes iterative testing and analysis. Early in the term, teams complete a pretotyping assignment that emphasizes low-cost, rapid experimentation to test the core experience of a product concept (“build it, test it”) and learn quickly what not to do. As projects mature, teams produce and demonstrate multiple prototypes, including “looks-like” prototypes and “acts-like” prototypes that show critical subsystem functionality and overall user interaction in live demonstrations. Course activities also explicitly frame hypothesis testing and customer discovery as part of the innovation process, encouraging students to use evidence from user-facing tests and prototype demonstrations to refine both technical features and value propositions.

The junior-level **Water Chemistry** course integrates disciplinary content with an extended open-ended team project in which students design a K–12 hands-on learning activity linked to water chemistry concepts addressed in the course and aligned with *TeachEngineering* requirements. Deliverables include an experimental procedure, instructional slides for K–12 teachers, a student workbook, and assessment materials, and teams present and demonstrate their activity to peers, teaching assistants, and expert judges—often requiring iterative refinement of procedures and materials to support clarity, feasibility, and engagement. Nearly all of the students (96%) were also co-enrolled in a one-credit laboratory course associated with Water Chemistry that emphasizes hands-on analytical techniques and prescriptive experimental procedures (e.g., titration-based and other measurements of water quality parameters), reinforcing experimentation as structured measurement and data interpretation in a controlled lab setting.

The **Fate and Transport (F&T)** course taken by environmental engineering majors in the fall semester of their senior year targets ABET Student Outcome 6 (SO6), experimentation, and satisfies the environmental engineering program criterion related to experimentation in air, water, and soil systems. The course includes three major open-ended laboratory design experiences focused on contaminant partitioning, transport processes, and remediation approaches. In these labs, students were required to design experimental procedures, identify relevant variables, collect and analyze data, and draw evidence-based conclusions about system behavior and treatment effectiveness. These activities emphasized experimentation as a means of understanding system behavior and evaluating the performance of alternative approaches under varying conditions.

The environmental engineering **capstone** design consists of team-based projects recruited from utilities, consulting firms, and student design competitions and is organized around three phases: proposal/scoping, alternatives assessment, and a preliminary design report (approximately 30% design). Experimentation in capstone is primarily embedded through structured evaluation of alternatives—defining constraints and criteria, conducting quantitative comparisons (including cost, sustainability, and regulatory considerations), and justifying recommendations using decision matrices and sensitivity/uncertainty reasoning. In some projects, teams also incorporate bench-scale treatability testing (e.g., jar tests or adsorption tests) to support selection and preliminary sizing of treatment processes, though this is project-dependent rather than universally required.

Survey instrument
The survey instrument used in this study was adapted from the measures reported by Schar et al. [19], which include a very brief Innovation Self-Efficacy scale (ISE.5) grounded in Dyer et al.'s [4] innovation-related behaviors (questioning, observing, experimenting, idea networking, and associational thinking), along with an Innovation Interests scale (INI) and a Career Goals: Innovative Work scale (CGIW). Schar et al. report that the ISE.5 was derived from the longer Dyer Innovative Behavior Scale and demonstrates evidence of reliability and validity for use with undergraduate engineering students. In the present study, we adapted the response format to a 7-point Likert-type scale to provide greater response sensitivity, while retaining the brief item structure. Our survey also included demographic items at the end.

The present paper focuses specifically on the two survey items related to experimentation. The self-efficacy item used the stem: "Below is a list of activities. Please think about how confident you are in your ability to do these activities. How **confident** are you in your ability to: **Experiment as a way to understand how things work**." Response options were: 1 – No confidence; 2 – Very little confidence; 3 – Somewhat confident; 4 – Confident; 5 – Highly confident; 6 - Very highly confident; 7 – Extremely confident. The interest item asked: "How much **interest** do you have in: **Experimenting in order to find new ideas**." The response options were: 1 – Not at all interested; 2 – Disinterested; 3 – Somewhat disinterested; 4 – Neutral; 5 – Somewhat interested; 6 – Interested; 7 – Extremely high interest. Consistent with our broader framing of experimentation in engineering as multi-typed, these two prompts may cue somewhat different orientations toward experimentation: the confidence item emphasizes explanatory or understanding-oriented experimentation (e.g., learning how systems behave), whereas the interest item emphasizes generative experimentation oriented toward ideation and discovery.

The survey was administered at the start and end of the semester in four of the courses: FY Projects (Spring 2024, Spring 2025), EnvE Water Chemistry (Fall 2023), EnvE Fate & Transport (Fall 2023), and Invention & Innovation (Spring 2024, 2025). The survey was only administered at the end of the semester in EnvE Capstone Design (Spring 2024, 2025) and EnvE Fate & Transport in Fall 2024. Enrollment in these courses ranged from 29 to 54. The second author visited each class to recruit students to participate in the research study. It was made clear to students that the survey was optional, would have no impact on their grades, and the instructor would not know which students opted to participate in the research. About 10 minutes total of class time was provided for the recruitment process and to allow students to complete the short survey by linking to Qualtrics. Students were offered an incentive of a single $50 Amazon e-gift card awarded to one randomly selected student in each course for each survey administration. The second author de-identified all of the responses before sharing the data with the first author. Response rates ranged from 39% to 97% with a median of 71%.

Data Analysis

Data were exported from Qualtrics to Excel. Paired t-tests (Excel) and the non-parametric Wilcoxon Signed-Rank Test (IBM SPSS) were conducted to compare confidence and interest responses in the same course, year, and time (e.g., pre) and pre/post differences (RQ2), when 10 or more paired responses were available. To compare different courses, heteroscedastic t-tests (Excel) and Mann-Whitney U tests (SPSS) were conducted. A p-value of 0.05 or lower was considered indicative of significant differences. Effect sizes were calculated using Cohen's d values. Additionally, correlations between experimental confidence and interest were assessed using Pearson correlations (r, Excel) and non-parametric Spearman rho values (ρ, IBM SPSS). To determine if there were differences between the pre and post correlations, tests were conducted in cocor [20].

Limitations

This study has a number of limitations. The two survey items provide complementary but coarse coverage of experimentation across engineering contexts. The self-efficacy (confidence) item primarily reflects explanatory/characterization-oriented experimentation (Types 1, 5, and 6), whereas the interest item more strongly reflects exploratory/generative experimentation (Types 3 and 8). Notably, the confidence item assesses experimentation in a general explanatory sense, while the interest item frames experimentation explicitly as a means of finding new ideas; this difference in framing may contribute to divergence between confidence and interest responses. Accordingly, patterns where confidence and interest diverge may partly reflect the two items cueing different orientations toward experimentation, which warrants caution when interpreting differences across courses.

Student self-reports are subject to known limitations, including measuring confidence rather than actual experimental competence and potential social desirability effects. Sample sizes were modest within individual courses, and some courses also had response rates of only 39-45%. For RQ1, the data were cross-sectional rather than longitudinal, and while most respondents were environmental engineering majors, students from other disciplines were included in the FY projects and Invention & Innovation courses, which may confound comparisons by student rank. In RQ2, pre/post changes should not be attributed solely to the focal course, as cumulative experiences from other coursework and co-curricular activities may also influence students' attitudes toward experimentation. Finally, because all data were collected at a single institution, generalizability to other institutional contexts is limited.

Results

RQ1. Experimentation Self-Efficacy and Interest Across Academic Rank

The results in Table 3 show that the levels of student confidence in experimentation were highly variable among different classes on the pre-survey (ranging from 4.1 confident to 5.2 highly confident) and the post-surveys (ranging from 4.7 to 5.8 very highly confident). There were no clear trends with student rank (Figure 1). Across different semesters of the same course, the pre confidence ratings showed large differences (e.g., FY Projects pre 4.1 in 2024 vs 5.1 in 2025).

Table 3. Students' experimentation confidence and interest with correlations

Class, Semester, Pre or Post	Curriculum Semester	n	Confidence Mean ± stdev	Interest Mean ± stdev	Correlations r, ρ
FY Projects Sp24 pre	2	12	4.1 ± 0.7	5.4 ± 0.5**	0.42 , 0.42
FY Projects Sp25 pre	2	30	5.1 ± 1.2	5.5 ± 1.0	0.39, 0.40*
FY Projects Sp24 post	2.5	12	4.8 ± 1.3	5.4 ± 0.9	0.18, 0.20
FY Projects Sp 25 post	2.5	14	5.3 ± 1.4	5.9 ± 1.1*	0.66, 0.68 **
Inv&Innov Sp24 pre	6	32	5.2 ± 1.5	5.8 ± 1.0*	0.50, 0.49 **
Inv&Innov Sp25 pre	6	29	4.6 ± 1.4	5.7 ± 0.9 **	0.34, 0.35
Inv&Innov Sp24 post	6.5	26	5.8 ± 1.3	5.8 ± 1.3	0.57, 0.48 **
Inv&Innov Sp25 post	6.5	26	5.2 ± 1.2	5.9 ± 1.0 **	0.35, 0.40*
EnvE WChem F23 pre	5	37	4.1 ± 1.4	5.3 ± 1.0 **	0.54, 0.52 **
EnvE WChem F23 post	5.5	39	4.7 ± 0.9	5.3 ± 1.0 **	0.63, 0.53 **
EnvE F&T F23 pre	7	23	4.5 ± 1.3	5.8 ± 0.9 **	0.53, 0.44*
EnvE F&T F23 post	7.5	25	5.1 ± 1.2	5.6 ± 1.0	0.44, 0.45*
EnvE F&T F24 post	7.5	18	5.3 ± 1.2	5.5 ± 0.9	0.35, 0.38
EnvE Capstone Sp24 post	8.5	31	5.2 ± 1.1	5.6 ± 1.0*	0.46, 0.49 **
EnvE Capstone Sp25 post	8.5	26	5.2 ± 1.1	5.7 ± 1.1	0.42, 0.45*

* sig. < 0.05, ** sig. < 0.01

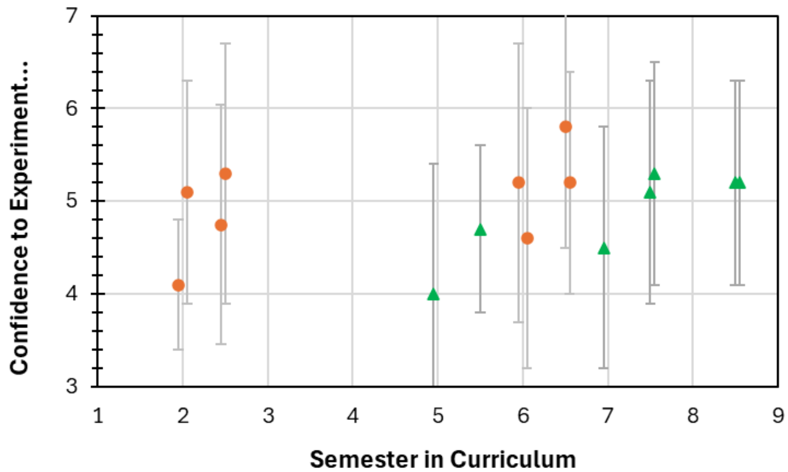

Figure 1. Student confidence in experimentation measured in courses that occur in different semesters of the curriculum. Mean represented by the symbols, with green triangles the EnvE courses. Standard deviation is represented by the error bars. Jittered to enhance visibility.

First-year design students had surprisingly high confidence (particularly on the pre-survey in Spring 2025), exceeding some cohorts of upper-division EnvE students. On the post-survey, the impact of prototyping and open-ended design projects could bolster their self-efficacy.

Similar to experimentation self-efficacy, students' interest in experimentation was variable among courses without trends in rank (e.g., more senior students were not more interested than first-year students and students in earlier semesters). Average experimentation interests were similar to or higher than experimentation confidence in all courses.

RQ2. Paired results across a single semester

Paired pre/post experimentation confidence and interest in the courses across a single semester are summarized in Table 4. (Note that FY Projects Spring 2024 is not included since there were only 6 students with paired pre and post data). Experimentation self-efficacy increased in all courses except FY Projects. The FY Projects course had only 12 paired responses, and this sub-set of the 30 pre-survey respondents had an unusually high pre confidence (see Table 3, 5.1 among all 30 vs 5.6 among the 12). Experimentation interest did not change significantly across the semester in any of the courses.

Table 4. Paired pre/post data (mean ± standard deviation) and statistics

Group	n	Self-Efficacy			Interest		
		Pre	Post	p_w, p_t, d	Pre	Post	p_w, p_t, d
FY Projects Sp25	12	5.6 ± 1.3	5.3 ± 1.4	.45, .37, 0.26	5.8 + 1.1	6.0 ± 1.0	NC, .55, 0.17
Inv&Innov Sp24	26	5.2 ± 1.5	5.8 ± 1.3	.05, 0.04, 0.41	5.8 ± 1.1	5.7 ± 1.3	.57, .56, 0.13
Inv&Innov Sp25	26	4.8 ± 1.4	5.2 ± 1.2	.06, .04, 0.33	5.7 ± 0.9	5.9 ± 1.0	.22, .17, 0.20
EnvE WCh F23	35	4.1 ± 1.4	5.0 ± 1.2	.002, <.001, 0.49	5.3 ± 1.0	5.4 ± 1.1	.73, .69, 0.03
EnvE F&T F23	20	4.4 ± 1.2	5.2 ± 1.2	.005, .001, 0.65	5.7 ± 0.9	5.6 ± 1.0	.62, .61, 0.10

p_w = p value from Wilcoxon Signed-Rank test; p_t = p value from paired t-test; d = Cohen's d effect size; NC = not able to calculate because too many paired values are identical

RQ3. Correlation Between Experimentation Confidence and Interest

The correlations between self-efficacy and interest were summarized in Table 3. Overall, the correlations were generally moderate to weak; some of the Spearman coefficients were not statistically significant. The strongest correlations were observed in the FY Projects Spring 2025 post-survey (0.66). These correlations align with expectations from the theoretical models. Higher interest can foster confidence, possibly by motivating learning. Conversely, individuals may be more interested in topics they believe they are competent in. Statistical comparisons of the correlations found no statistical difference in the pre and post correlations within the same semester (among paired students within the same course; data not shown).

These findings suggest that engineering students' experimentation confidence and interest evolve differently across educational stages and course types. While interest in experimentation remained high and stable, confidence may fluctuate based on students' prior experiences and course design.

Discussion and Conclusions

The quantitative findings yielded unexpected results. One might expect that students' confidence in their abilities would increase during college. However, perhaps the engineering curriculum provides little opportunity to practice the specific types of experimentation queried on the survey - in this case, experimentation as a way to understand how things work. Some of the first-year design courses sometimes include reverse engineering (deconstructing products) and prototyping in FY Projects, and the Invention & Innovation course might also foster these abilities. It can also be true that students may actually improve their abilities while also decreasing in their confidence [21],[22]. For example, first-year engineering students often enter with inflated self-efficacy, and then as they gain disciplinary knowledge and confront more authentic standards, self-efficacy recalibrates and may decrease even as actual competence increases [23]. Regardless of these issues, confidence is important even when poorly calibrated, as it can provide motivation for learning. Another consideration is that this public university is located among the states that adopted the NGSS to a large extent starting in 2018. Thus, students may have been practicing this skill in K-12 but then entered college courses that were taught in more regimented ways that perpetuate the idea of singular right answers (such as the descriptions of traditional engineering science courses that predominate in the sophomore year). Paired pre/post survey responses within individual junior and senior-level engineering courses, which included open-ended projects, did show higher experimentation confidence in the post surveys.

Student interest in experimenting in order to find new ideas was generally high in all courses, without obvious trends with student rank or longitudinally (pre/post-comparisons).
Exploring correlations between experimentation confidence and interest, it is important to remember that the experimentation items were not a direct match. Students rated their level of confidence in experimenting to understand how things work versus their interest in experimenting in order to find new ideas. Thus, the context of experimentation may have been significant. Nevertheless, weak to moderate correlations in these experimental items were found.

If students' experimentation confidence and interest are of direct interest, survey items could be refined to explore different experimentation sub-types or be phrased to experimentation skills more generally. If experimentation in the service of innovation is of particular interest, the confidence items could be reworded to more directly measure the idea. The quantitative results point to the need to pursue qualitative studies (e.g., focus groups or interviews) and/or explore direct evidence (e.g., samples of student work) to understand why these effects (or lack of effects) were found. Future research should also investigate how students conceptualize the relationship between experimentation and innovation.

Engineering faculty should consider whether they hope to foster confidence and interest in these skills related to experimentation. If so, they can integrate particular teaching methods and student assessment to evaluate these. More broadly, groups of faculty may consider whether their degree programs should aim to foster these abilities and interests. If programs are interested in graduating students who possess skills and interests in innovation, fostering experimentation abilities is an important behavior to support this goal.

Acknowledgements
This material is based upon work supported by the National Science Foundation under Grant Number 2205067. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

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