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Illuminating Contexts that Influence Test Usage Beliefs and Behaviors among Instructors of Fundamental Engineering Courses

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Abstract

This research paper illuminates the different contexts elicited by seven instructors who taught fundamental engineering courses (FECs) when discussing their test usage beliefs and behaviors, beginning to address a gap in engineering education research on instructors' beliefs and behaviors and test usage in engineering courses. Tests and exams are typically heavily used in FECs like statics, dynamics, thermodynamics, and other courses in various engineering disciplines. Understanding why engineering instructors heavily rely on tests to assess student learning in these courses can be crucial in promoting the use of more diverse types of assessments, such as portfolios, concept inventory, reflection-based practices, project-based practices, and intentionality in terms of designing, administering, and interpreting tests, but research has been scarce on documenting research on this topic.

Conversations around why instructors make certain course decisions typically involve the contexts these instructors are situated in, emphasizing how important contexts are in terms of influencing decision-making in these courses. Illuminating some of these contexts can be helpful to further understand instructors' beliefs and behaviors in course decision-making, specifically on heavily using tests in fundamental courses. We answered the research question: *What are some of the contexts that seven instructors of fundamental engineering courses raise when discussing their test usage in their courses?* The data are collected as part of a larger multi-case study that explores test usage beliefs and behaviors of seven individual engineering instructors (seven cases). Multiple sources of data and evidence triangulate to shape the case profiles for these seven instructors, with contexts emerging as an important element of these profiles.

Our findings show several key contexts discussed substantially by some of these seven instructors, though not all instructors discussed the same contexts. These contexts include the influence of inertia to continue using tests, course context that includes large enrollment, and the limited autonomy for some instructors to make changes to assessment in the courses. These contexts show some intertwining characteristics to influence test usage among the participants. In addition, our findings support existing literature on inertia and course context and prominent contexts to influence course decision-making, and this paper focuses on the test usage as a form of course design decision.

Keywords: Test, exam, instructor, context, beliefs, behaviors

Introduction

Test usage is prominent in fundamental engineering courses (FECs) (Sheppard et al., 2009). Understanding what factors lead to substantial or heavy usage is important in thinking about how to promote diverse assessments in engineering education, considering research that shows heavy test usage can have negative impacts on learning, such as student motivation to learn (Elliot et al., 1999; Major et al., 2020; Tan, 1992; Vaessen et al., 2017). However, knowing that instructor course decision is not strictly based on the instructor themselves (Lattuca & Stark, 2011; Stark, 2000), understanding the contexts that influence the decision to use tests in their courses is important to advance our knowledge in the engineering education research about assessment usage and decisions in engineering courses. This analysis is part of a larger study to understand instructor beliefs and behaviors on test usage, striving to contribute to this understanding by answering the research question: *What are some of the contexts that seven instructors of fundamental engineering courses raise when discussing their test usage in their courses?*

Literature Review

Literature in higher education largely has shown that contexts play an important role in the education process. Some studies and theories discuss the role of contexts a student situates in influencing student learning, such as understanding college impacts on student transition into college (Terenzini & Reason, 2005), the class environment affecting student learning and motivation (Abadi et al., 2017; Lawanto & Febrian, 2018; Lord et al., 2012; M. Te Wang & Eccles, 2013), students choosing their postsecondary pathways (X. Wang, 2013), and graduate student teaching performance (Reeves et al., 2018). Similarly, studies are also abundant in understanding the faculty or instructors' perspectives in terms of contexts. Lattuca and Stark (2009) created a theory that encapsulates how one can shape a college curriculum. The theory encompasses a wide range of contexts that influence the shaping, such as external influences of market forces, government, and accrediting agencies, institutional influences of college missions and resources, and unit-level influences of faculty, discipline, and student characteristics. Stark also created the Contextual Filters Model that provides an overview of the various contexts that influence course planning for college faculty (Lattuca & Stark, 2011; Stark, 2000; Stark et al., 1988). A study by Lund and Stains examines unique environments and contexts of departments in influencing STEM faculty's teaching practices and finds that disciplinary differences exist and have shown potential associations to level of adoption of evidence-based instructional practices (2015). Another study shows similar findings where faculty's teaching practices differ based on the contexts they teach in (Lindblom-Ylänne et al., 2006). Some studies also detail the challenges faculty experience in efforts to adopt evidence-based practices (Choi et al., 2018; Gaff, 1978), and we frame challenges as another form of context that influences teaching practices. These show substantial literature on context influence in the education process, and engineering education should continue working toward understanding these contexts in pushing for the improvement of the education process.

Several types of contexts have been studied in existing literature, and we focus on three in this paper. First, faculty autonomy is one important context in influencing how they design their courses. Articles have mentioned that faculty autonomy exists, and faculty autonomy seems to be important to maintain among faculty members while working toward promoting innovative teaching practices (Aberbach & Christensen, 2018; Angelo & Cross, 1993; Recktenwald et al., 2018). Gaff (1978), when discussing overcoming faculty resistance toward teaching improvements, specifically mentioned that some faculty think "*proponents of teaching improvement might pressure them to use some particular methods or techniques and thereby limit their own autonomy*" (pg. 47), emphasizing the importance of autonomy for faculty in terms of how they design their courses. Stark (2000) also found that faculty of introductory courses in non-research universities believed they had considerable autonomy in course planning, strengthening the claim in higher education. It must be noted that this non-exhaustive literature review does reveal the lack of articles on faculty autonomy generally in engineering education.

Second, course contexts, such as class size and types of courses, have been discussed in engineering education literature. Many studies have noted the increasing enrollment in courses in higher education, particularly due to budget constraints (Chapman & Ludlow, 2010; Toth & Montagna, 2002). Some studies argue there is no consensus on whether larger enrollment is problematic to student learning (Feldman, 1984; Toth & Montagna, 2002), but recent studies have shown that larger enrollment can affect the learning environments, with impacts like negative impact on teaching evaluation (Bedard & Kuhn, 2008) and student perceptions of the amount learned, course rating, and expected course grade (Chapman & Ludlow, 2010; Monks & Schmidt, 2010). Some studies also attempt to explain why these phenomena happen, with Cuseo (2007) suggesting some consequences of large enrollment such as reliance on lectures for instructions and reduction in instructor-student interactions, with Gibbs and colleagues (1996) agreeing with some of these consequences. Overall, studies have shown there are impacts of large enrollment on the learning environment. In engineering education, research has studied similar impacts (Boylan-Ashraf & Haughery, 2018; Hartman, 2008; Owen & Rolfes, 2015). Boylan-Ashraf and Haughery examined large enrollment classes and the context influence on failure rates in three FECs: mechanics of materials, dynamics, and introduction to circuit, while Owen and Rolfes did so on a professional communication course for engineering students to develop a theoretical groundwork for a larger study on communication efficacy. Hartman, on the other hand, documented their decisions as an instructor when teaching a large enrollment engineering economy course for the first time. Hartman continued to use tests, though because of the content, they only took 5 minutes to grade each test, showing their justification for using tests continuously in a large enrollment course. Research should expand Hartman's experiences with more scholarship to understand how these influence faculty assessment decisions, such as using tests, which our findings will begin to address.

Another form of course context is the type of courses that influence the faculty's course decisions. In engineering curricula, courses are typically in the form of introductory courses, fundamental engineering courses, laboratory courses, and capstone courses (Lord & Chen, 2015; Sheppard et al., 2009). Stark (2000) has argued that instructors of introductory courses tend to shape their goals of the course based on nature of the disciplines, and subsequently their course planning. In engineering education, however, studies on the types of course and their influences on instructors' course decisions are scarce.

Third, inertia, or the notion of "we have been doing this," is also a prominent context that can influence instructor course planning and decisions. Research has shown that resistance to changes among faculty or instructors tend to have this as one of the major reasons, as statements like "we have also done it that way" or "if it ain't broke, don't fix it" exemplifying this concept in higher education (Lane, 2007; National Academy of Engineering, 2005; Reeping et al., 2018). In engineering education, literature on this contact is scarce (Reeping et al., 2018), and there is a need to further explore to better understand inertia's influence on instructors' course decision-making. Overall, the literature review has uncovered several research gaps that the engineering education should begin addressing.

Conceptual Framework

The conceptual framework for the larger study is based on Eccles' Situated Expectancy-Value Theory (SEVT), a motivation theory that focuses on understanding student achievement-related choices through expectancy and subjective task values (Eccles, 1983; Eccles & Wigfield, 2020; M. Te Wang & Eccles, 2013; Wigfield & Eccles, 2000). We employed the socializer perspective with which Eccles and colleagues argued that student expectancy and subjective task values are influenced by their surroundings, including the instructors and learning environments (Eccles, 2007). Figure 1 shows the conceptual framework.

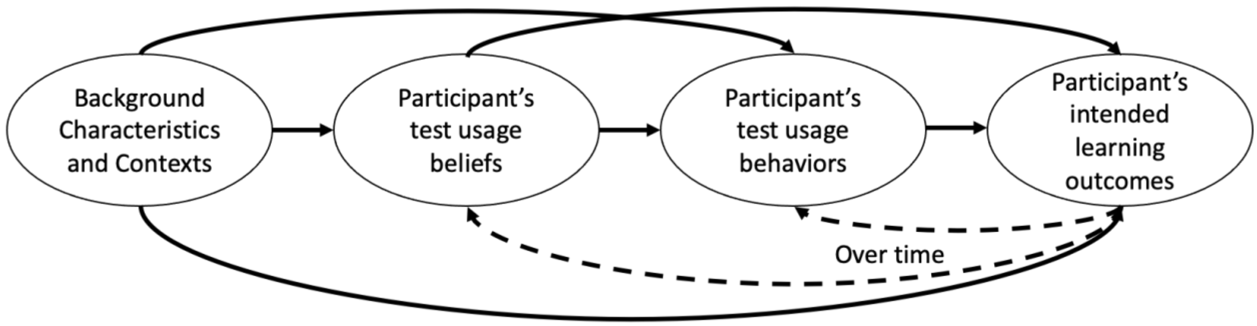

Figure 1: The conceptual framework that guided our research. A similar diagram illustrating an adaptation of the conceptual framework for one participant is presented in Chew and Matusovich (2022).

For this paper, we focus on the background characteristic and context component of the conceptual framework to begin addressing the research gaps in understanding contexts and context influence on engineering instructors' course decisions. We will explore three specific contexts that emerged from our data analysis.

Methods

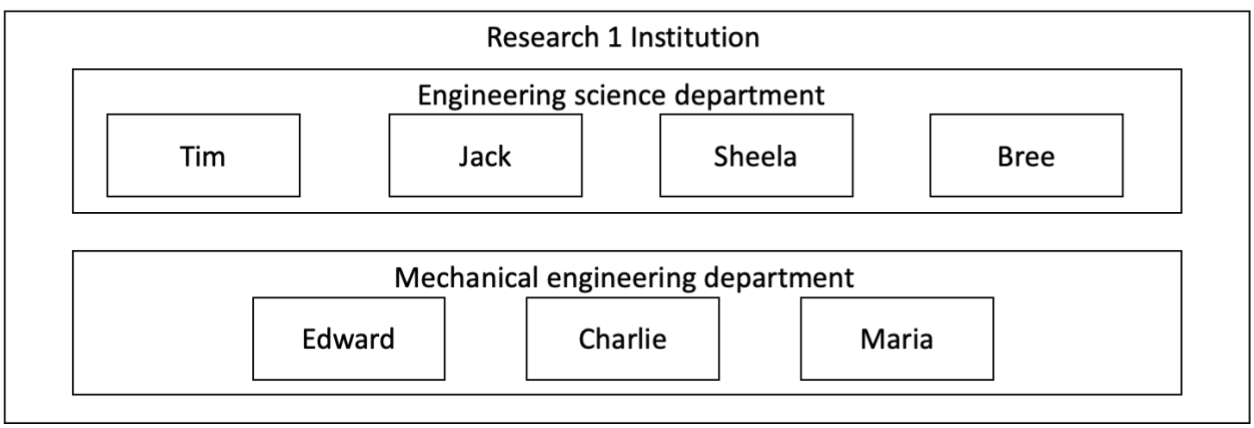

Figure 2: The case definition for the larger study as background information to understand the findings on contexts. A similar diagram is presented in Chew and Matusovich (2022).

We employed Yin's case study research methodology to answer the research question (Yin, 2018). The seven participants were individual cases (Figure 2), which was an intentional research design as the conceptual framework in Figure 1 implies the individuality of test usage beliefs and behaviors. For instance, two instructors from the same department can have different background characteristics and contexts that may result in different beliefs and behaviors on test usage. In addition, these two instructors may also have different intended learning outcomes for the same course they are teaching. Hence, having each participant as an individual case provided a detailed and nuanced view of these beliefs and behaviors. We recruited these participants using purposeful sampling to focus on instructors who taught fundamental engineering courses, with a range of year of teaching experiences. Relevant participant demographic information is presented in Table 1.

Table 1: Relevant demographic information for the participants. The years of teaching are presented in ranges to ensure the confidentially of the participants.

Participant	Years of Teaching	Rank
Tim	More than five years	Teaching Assistant Professor
Jack	Less than a year	Instructor
Sheela	Around five years	Instructor
Bree	More than five years	Teaching Assistant Professor
Edward	More than ten years	Professor
Charlie	Around ten years	Associate Professor
Maria	Around three years	Assistant Professor

Each participant consented, as per an approved Institutional Review Board (IRB) protocol, to engage in two semi-structured interviews and share their course syllabi and sample tests. The course documents were analyzed in between the two interviews to allow questions about the syllabi and tests in the second interview, hence why we intentionally had the first interview early in the semester and the second interview later in the semester. The semi-structured interviews included questions such as "How did your past experiences as an engineering student influence your thoughts about exams," "Are there any specific institutional, departmental, or course policies that you think of while designing classroom tests," and "while designing this sample tests/exams, how did program contexts (policies, culture) influence your decisions and implementations?" In addition, we collected public institution documents, such as faculty and student handbook, to provide information on these interviews. Using multiple sources of evidence to make claims is one key component of Yin's case study research methodology (Yin, 2018). It must be noted that the data were collected in Spring 2021 during which these participants were teaching virtually due to the Covid-19 pandemic.

The contexts emerged from the analysis of the semi-structured interviews and public documents. We employed a priori and emergent coding for the semi-structured interviews and the documents (Bowen, 2009; Miles et al., 2014). Thematic analysis then helped with consolidating the codes and coded excerpts to higher-level themes, and in this case, the contexts formed after thematic analysis was performed (Braun & Clarke, 2012). The following section presents the three contexts that answer the research questions.

Limitations

While interpreting findings from our research, we advise the readers to consider these two limitations. First, our study was designed with a focus on transferability instead of generalizability. The case study research methodology we selected provides detailed and deep dives into these participants' discussions on contexts that influence their test usage, and the readers should focus on transferring these findings to relevant contexts as the participants were all situated in a Research-1, public institution. Second, the findings were based on data collected as a snapshot of these participants, meaning that we acknowledge some of these beliefs and behaviors may be fluid and changing. However, we argue this does not diminish the importance of our findings because they provide a foundational understanding of contexts and test usage that can inspire and promote further work on the topic.

Results

Three prominent contexts emerged from the analyses to answer the research question: 1) Autonomy, 2) course context, and 3) inertia in engineering education.

Autonomy

Analyses of the interviews and course syllabi showed that there was a difference in autonomy on test usage between the two departments, primarily explained by the structure of the courses offered by these departments. In Engineering Science (ES), all four participants informed us that they did not have autonomy in changing the structure of their assessment activities. For background information, all instructors of the three service courses offered by ES (statics, solid mechanics, and dynamics) must use tests as the main assessments. The service courses had hundreds of students taking them at the same time in different sections, taught by different instructors. The tests themselves (midterm and final exams), not counting quizzes, constituted 85% of the student course grade, a significant portion of the grades. We interpreted this as heavy usage of tests in the course. Jack explained that the assessment structure was negotiated among engineering departments in the institution, implying the lack of will or initiative to revisit them.

"*That [grade weighting and assessments] at some point in the past was negotiated with the other departments in sort of an agreement that they came to in how the students will be graded. I don't really know the details of that it's been there for longer than I have…And we've just kind of kept doing that same thing*."

It must be noted that instructors had autonomy to write their own midterm exams as Jack noted that the instructors were "*responsible for making the tests for their sections*," but not the final exam as the final was a standardized, multiple-choice exam for all sections and was written by the course supervisor.

In triangulating this finding with the public documents from the institution, such as the faculty and student handbooks, it showed consistency in one dimension and inconsistency in another. The consistency was that the institution had tests as the assumed form of assessment, especially for the final assessment in each course. This interpretation was supported by the handbook specifically explained that all courses will get a final exam time slot that the instructors can decide whether to use them, with specific language on the logistics. In addition, the Covid-19 pandemic public documents supported the interpretation of tests as an assumed form of assessment in this institution, providing substantial resources for instructors on how to conduct tests in virtual classrooms.

The inconsistency, however, emerged from the handbook that stated the autonomy instructors had in terms of making course decisions, with language that stated "*Grading is a teaching tool that provides specific feedback to students. Faculty should keep this in mind when designing assignments and course work*" and "*the assignment of a grade is the sole prerogative of the instructor of the class*," hinting at the autonomy the faculty in this institution had in terms of course and grade decisions. The lack of autonomy emerged as an inconsistency, though not raised during the interviews with any of the ES faculty aside from explaining the structure of the service courses.

In comparison, the ME department seemed to show a range of autonomy for the instructors to change their assessment activities, though all three ME participants still heavily used tests, with tests constituting around 80% of the students' total course grades. We can claim that they had autonomy because all three of their syllabi showed different types of assessment activities used. For instance, both Maria and Charlie's thermodynamic course syllabi (also different sections taught by different instructors like the service courses) documented different types of assessment activities, with Charlie's having a project as part of the repertoire (Table 1).

Table 1: Maria and Charlie's Course Breakdown

Thermodynamic Course Grade Breakdown	Maria	Charlie
Homework/Quizzes	15%	15%
Tests (Midterms)	60%	45%
Final Exams	25%	30%
Project	Did not use	10%

In addition, when asked about their assessment structure, Edward said that they "*developed over the years, trial and error*," implying that they had the autonomy to make changes, such as deciding the weightage of the tests and the number of tests given in their courses. Edward also implied that they designed their own final exam, and this assertion was supported by Maria.

However, Maria discussed the lack of autonomy in making changes to their thermodynamic course assessments. She was also told by her senior peers (higher-ranking professors) to not make many changes in her courses considering she was a tenure-track assistant professor. She said that: "*…To be honest with you the senior professors, they don't actually motivate young faculty to change because they want us to focus on the research…*" Even though professors in the ME department had relatively higher level of autonomy than their ES peers, she was told not to exercise much of the autonomy to focus on her research for her tenure case. This shows that the nuanced interpretations emerged from the data on the level of autonomy, and in this case, within the same department, the level of autonomy could be different depending on one's rank.

Overall, the seven participants from two departments showed that both departments had different levels of autonomy for the fundamental engineering courses, specifically because the service courses were offered to students from multiple engineering departments while the FECs were not specifically offered to students from other engineering departments.

Course Context

The participants generally pointed to two types of course contexts while considering why they used tests in their FECs. Aside from Edward, most of them raised and discussed large enrollment courses as the main reason, with the explanation being "tests being convenient and easy for grading." Jack mentioned that:

"*The other reason is entirely practical that if I have 200 students and I have to grade the exam. The final was like 12 or 15 questions and, if I have to grade all that in 48 hours it's physically impossible to do so. I need something that I can just put through a scantron.*"

It must be noted that Jack was referring to the final exams where all questions were multiple-choice questions, and the idea of having to grade 200 students within two days was not possible considering the quick turnaround needed. This quote specifically represented the sentiment some participants had on why tests were convenient for large enrollment courses. Bree also supported this, saying that "*foundational courses and high volume, like high enrollment courses I would definitely [do] that*." These point to large enrollment or large number of students being an important consideration in using tests, considering the need for a quick turnaround on grading with the high volume of students.

Another context that was mentioned by several participants was the type of courses they were teaching. Sheela explained that they were comfortable using tests in certain types of courses and not in others.

"For the engineering physiology class, it was more of a low stakes quiz kind of deal so that one was an elective class, so I felt more comfortable just sort of you know, giving them homework and quizzes, but they weren't as heavily weighted as like in the statics class. There was also a big project at the end of that class that was probably… I can't remember the exact weighting, but it was weighed more."

Here, Sheela explained that they were comfortable with not using tests in elective classes, and listed the other types of assessments they used, such as more homework, quizzes, and projects. They further elaborated that:

"*Whereas with the elective courses, those are more sort of self-contained courses and also they're a little upper level so… the level of the students in those classes is also different…most of them are interested in the topic in doing that class. They have a lot of experiences and sort of self-learning so that you can give them something like a project and they know how to do the research and figure out things*."

In this quote, Sheela explained that elective courses were different from FECs, arguing that elective courses were more self-contained than FECs in which provided the concept building blocks to help students understand important engineering concepts. In addition, they discussed the different types of students in the elective courses, saying that students were more interested in the topics and had a lot more of learning experiences at that point so that they could self-learn. Projects, in this case, were something appropriate at this juncture.

The evidence above shows that our participants considered course context while determining whether to use tests in their courses. Jack defended the use of multiple-choice final exams in the solid mechanics course because he had to consider grading quickly for a large number of students. Sheela, on the other hand, explained that she felt comfortable not using tests in an elective course because of more prepared and interested students with the content. Overall, course context emerged as a prominent consideration among our participants while using and explaining the decisions behind continuing to use tests in their FECs.

Inertia

Inertia was raised by three participants and hinted at by one more. Although only three participants mentioned inertia as part of the context, it became a prominent finding for our study because literature has repeatedly shown inertia as a reason why faculty continued certain practices.

Jack discussed that the reason why engineering instructors continued to use tests was "*probably just inertia. It's always been that way…*" They further elaborated that "*It's always been that way that's how [they were] evaluated in undergrad that seemed like a good way for* *[them] to keep doing*." Here, inertia was an important context that compelled Jack to continue using tests in their courses. Specifically, Jack explained that the inertia was partly because they were also assessed with tests as an engineering student. Because that worked for him, they continued to use tests in their courses. In addition, Jack's lack of will or thought to change the assessment structure in the service courses that used tests heavily, as mentioned in the autonomy section, also seemed to stem from the inertia context. Jack explained that the test-heavy assessment structure had "*been there for longer than I have…and we've just kind of kept doing the same thing*." The evidence shows Jack's reasoning behind heavy test usage (around 80% of the student course grade) also had an influence by inertia.

Maria provided another perspective on inertia as a context that compelled continued test usage. Maria explained that they wanted to change some of the assessments used in their thermodynamic courses. However, they were told by senior professors (Maria was a new assistant professor in the department) that they should not change anything assessments in the courses because they should focus on their research for their tenure case, which we interpreted as also a finding on autonomy earlier in this paper.

"*The problem is, as I said, I'm an assistant Professor that's my third year. To be honest with you the senior professors, they don't actually motivate young faculty to change because they want us to focus on the research, yeah, so it is a matter of well, maybe someday I have enough time to come out with something…*"

Maria elaborated that they hoped that in the future they might have enough time to make changes to the assessment structure in her thermodynamic courses, as they explained they preferred a course with different types of assessments.

Lastly, Charlie also discussed inertia as an important driver them continuing to use tests in their courses. Citing from Chew and Matusovich (2022), Charlie explained that:

"*I mean the real answer is just, that's one of the worst answers for almost anything, is because that's the way everybody's always known it pretty much. I think when I first started, I tried to make sure I sort of conform to what the usual or the typical ones were, and then, I guess, since then, I haven't put a put a ton of thought into it.*"

As explained in Chew and Matusovich (2022), Charlie specifically admitted here that they continued to use tests because everyone else was doing them, and engineering faculty pretty much always knew tests as the way to assess students. The results on inertia in this paper expanded on Chew and Matusovich (2022). The previous paper only focused on one participant's test usage beliefs and behaviors as a baseline for analyses on other participants, while this paper focused on the three contexts that emerged from the data based on all seven cases, instead of just one case like in the 2022 paper.

Discussions and Implications

There are three takeaways from this analysis. First, some contexts intertwine with each other to influence test usage among the seven participants. In this case, some participants from the engineering science (ES) department have clearly shown that there is a lack of will or thought to rethink the heavy usage of tests in the service courses, reflecting the lack of thought about changing the autonomy of faculty in the ES department. Research has shown that this lack of autonomy is not surprising, considering that autonomy is typically broadly defined and can manifest in different ways depending on the institution and the academic units within, such as a department (Aberbach & Christensen, 2018). The inconsistency between the institution's language on autonomy and the situation in the ES department also supports this claim and contributes to the existing literature on faculty autonomy. The lack of autonomy also intertwined with inertia (Gaff, 1978; Lane, 2007). Jack, the course coordinator of these service courses, explained that they did not know much of the details of the setup of the course structure and test usage since the setup has been established longer than they were instructor in the department. They implied that the department just kept doing it because no one knew of much of the details, showing the inertia at work. Thus, this shows the possible intertwining nature of different contexts in influencing test usage among these instructors of FECs.

Second, course contexts do seem to inform test usage decisions among these engineering instructors. For instance, large enrollment in the service courses led to the ES faculty not challenging the test-heavy assessment structure in these courses, with some of them arguing that tests were the only viable way for large enrollment courses in terms of assessing student learning and grading. Consistent with the literature, this shows that large enrollment continues to be a major consideration among instructors in terms of making course decisions, and assessment, including tests, is part of these decisions (Chapman & Ludlow, 2010; Stark, 2000; Toth & Montagna, 2002).

However, our study did not further examine whether these instructors would prefer using alternative forms of assessments, and future studies should address this gap. In addition, our study has also shown that some instructors argue for the use of tests only in certain type of engineering courses, such as FECs like statics, dynamics, and solid mechanics. As engineering education literature lacks studies on understanding how different types of courses influence assessment decisions, this study begins to contribute to this research gap, and calls for the community to examine this phenomenon further.

Third, inertia as a context is evident in test usage justification among our participants. As mentioned, some participants discussed several factors that show manifestations of inertia shaping test usage decisions. These factors include the lack of knowledge on other types of assessments, the loss of institutional memory that leads to the service course assessment structure, and the advice to younger faculty to focus on research instead of improving teaching and assessment. As described by literature, these are documented in higher education on why teaching improvement or changes can be difficult, with an explanation being that faculty is influenced by the various factors and contexts while they are making course decisions (Gaff, 1978). Our study shows the continuation of inertia as a context that influences test usage, and course decisions in general.

Research implications wise, our findings contribute to the efforts in addressing gaps in research with test usage in engineering classrooms from the instructors' perspectives, and in this case, the contexts that inform instructors' test usage in their classrooms. It must be noted that even though these three contexts have been part of the conversations with practitioners, documentations of these contexts have been scarce in engineering education research. Our paper contributes to addressing this scarcity.

Future research should focus on further understanding instructors' beliefs and behaviors with test usage, especially in FECs, and uncovering what shapes these beliefs that continue the behaviors of using tests substantially to assess student learning in FECs. Another complementary research direction is to focus on engineering students' perceptions on tests to understand how students are feeling and thinking while preparing and taking tests, in addition to how tests might have or have not helped them learn the engineering content and knowledge. Our study focused on the instructors' perspective as instructors have a certain level of control over course decisions, but we also want to assert that student perspective on test usage should be studied in engineering education.

In terms of practical implications, findings can be used to help the engineering education community to start working toward more intentionality in terms of test usage. For instance, the three contexts (autonomy, course context, and inertia) should help instructors raise questions about whether these contexts shape their test usage. If they do, what other possible assessments they can use to address these contexts and achieve similar assessment outcomes they want with tests. This can potentially lead to the reduction of frequency and length of tests, while using other ways of assessments in FECs.

In conclusion, our study shows three contexts that influence engineering instructors of fundamental engineering courses (FECs) in using tests in their courses: 1) autonomy, 2) course context, and 3) inertia. These contexts are largely consistent with the literature, but also reveal some research gaps that the engineering education community should think about addressing to improve our education processes. In addition, the community can use our findings to raise questions about test usage, introducing intentionality with test usage in engineering classrooms.

References

Abadi, M. G., Hurwitz, D. S., & Brown, S. (2017). Influence of context on item-specific self-efficacy and competence of engineering students. *International Journal of Engineering Education*, *33*(4), 1297–1306.

Aberbach, J. D., & Christensen, T. (2018). Academic Autonomy and Freedom under Pressure: Severely Limited, or Alive and Kicking? *Public Organization Review*, *18*(4), 487–506. https://doi.org/10.1007/s11115-017-0394-2

Angelo, T. A., & Cross, K. P. (1993). Classroom assessment techniques. In *Classroom assessment techniques, a handbook for college teachers*. Jossey-Bass.

Bedard, K., & Kuhn, P. (2008). Where class size really matters: Class size and student ratings of instructor effectiveness. *Economics of Education Review*, *27*(3), 253–265. https://doi.org/10.1016/j.econedurev.2006.08.007

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative Research Journal*, *9*(2), 27–40. https://doi.org/10.3316/QRJ0902027

Boylan-Ashraf, P. C., & Haughery, J. R. (2018). Failure Rates in Engineering: Does It Have to Do with Class Size? *Proceedings of ASEE Annual Conference and Exposition*. https://lib.dr.iastate.edu/abe_eng_conf/579/

Braun, V., & Clarke, V. (2012). Thematic analysis. In H. Cooper (Ed.), *APA handbook of research methods in psychology, Vol 2: Research designs: Quantitative, qualitative, neuropsychological, and biological.* (pp. 57–71). https://doi.org/10.1037/13620-004

Chapman, L., & Ludlow, L. (2010). Can downsizing college class sizes augment student outcomes? An investigation of the effects of class size on student learning. *The Journal of General Education*, *59*(2), 105–123.

Chew, K. J., & Matusovich, H. (2022). Fundamental engineering course test beliefs and behaviors: A case exploration of one instructor. *Proceedings - ASEE Annual Conference & Exposition*.

Choi, D. S., Earl, K. A., Cross, K., & Herman, G. (2018). The Challenge of Using Research-

Based Instructional Strategies: Insights from an Effectiveness Study of the Intrinsic Motivation Course Conversion. *International Journal of Engineering Education*, *34*(1), 141–154.

Cuseo, J. (2007). The empirical case against large class size: Adverse effects on the teaching, learning, and retention of first-year students. *The Journal of Faculty Development*, *17*, 5–21.

Eccles, J. S. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and Achievement Motives* (pp. 75–146).

Eccles, J. S. (2007). Families, schools, and developing achievement-related motivations and engagement. In J. E. Grusec & P. D. Hastings (Eds.), *Handbook of socialization: Theory and research* (pp. 665–691). Guilford Publications.

Eccles, J. S., & Wigfield, A. (2020). From expectancy-value theory to situated expectancy-value theory: A developmental, social cognitive, and sociocultural perspective on motivation. *Contemporary Educational Psychology*, *61*(May), 101859. https://doi.org/10.1016/j.cedpsych.2020.101859

Elliot, A. J., McGregor, H. A., & Gable, S. (1999). Achievement goals, study strategies, and exam performance: A mediational analysis. *Journal of Educational Psychology*, *91*(3), 549–563.

Feldman, K. A. . (1984). Class size and college students' evaluations of teachers and courses: A closer look. *Research in Higher Education*, *21*(1), 45–116.

Gaff, J. G. (1978). Overcoming faculty resistance. *New Directions for Higher Education*, *24*, 43–57.

Gibbs, G., Lucas, L., & Simonite, V. (1996). Class size and student performance: 1984-94. *Studies in Higher Education*, *21*(3), 261–273. https://doi.org/10.1080/03075079612331381201

Hartman, J. (2008). Does class size matter? Reflections on teaching engineering economy to small and large classes. *Proceedings - ASEE Annual Conference and Exposition*.

Lane, I. F. (2007). Change in higher education: Understanding and responding to individual and organizational resistance. *Journal of Veterinary Medical Education*, *34*(2), 85–92.

Lattuca, L. R., & Stark, J. S. (2009). *Shaping the college curriculum: Academic plans in context*. Jossey-Bass.

Lattuca, L. R., & Stark, J. S. (2011). Curriculum: An academic plan. In *Shaping the college curriculum: Academic plans in context* (pp. 2–22). John Wiley & Sons.

Lawanto, O., & Febrian, A. (2018). Investigating the influence of context on students' self-regulation during the capstone design course. *International Journal of Engineering Education*, *34*(6), 1951–1968.

Lindblom-Ylänne, S., Trigwell, K., Nevgi, A., & Ashwin, P. (2006). How approaches to teaching are affected by discipline and teaching context. *Studies in Higher Education*, *31*(3), 285–298. https://doi.org/10.1080/03075070600680539

Lord, S. M., & Chen, J. C. (2015). Curriculum design in the middle years. In *Cambridge Handbook of Engineering Education Research* (pp. 181–200). https://doi.org/10.1017/CBO9781139013451.014

Lord, S. M., Prince, M. J., Stefanou, C. R., Stolk, J. D., & Chen, J. C. (2012). The effect of different active learning environments on student outcomes related to lifelong learning. *International Journal of Engineering Education*, *28*(3), 606–620.

Lund, T. J., & Stains, M. (2015). The importance of context: an exploration of factors

influencing the adoption of student-centered teaching among chemistry, biology, and physics faculty. *International Journal of STEM Education*, *2*(1). https://doi.org/10.1186/s40594-015-0026-8
Major, J. C., Scheidt, M., Godwin, A., Berger, E. J., & Chen, J. (2020). Effect of test anxiety on first-year students' STEM Success. *Proceedings of the American Society for Engineering Education Annual Conference & Exposition (Virtual)*.
Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). Fundamentals of qualitative data analysis. In *Qualitative data analysis: A methods sourcebook* (3rd ed.).
Monks, J., & Schmidt, R. (2010). *The impact of class size and number of students on outcomes in higher education*. https://doi.org/10.2202/1935-1682.2803
National Academy of Engineering. (2005). *Educating the engineer of 2020: Adapting Engineering Education to the New Century*. The National Academies Press. https://doi.org/10.1115/esda2008-59324
Owen, C., & Rolfes, D. (2015). Communication Class Size and Professional Identity. *Proceedings - ASEE Annual Conference & Exposition*. https://doi.org/10.18260/p.23705
Recktenwald, G., Godwin, A., Sahai, A., & West, M. (2018). A corporate organizational model for scaling class size. *Proceedings - ASEE Annual Conference and Exposition*.
Reeping, D., McNair, L. D., Baum, L., Wisnioski, M., Patrick, A. Y., Martin, T. L., Lester, L., Knapp, B., & Harrison, S. (2018). "We've Always Done it that Way," An Exploration of Electrical and Computer Engineering Faculty Curricular Decisions. *Proceedings - Frontiers in Education Conference (FIE)*.
Reeves, T. D., Hake, L. E., Chen, X., Frederick, J., Rudenga, K., Ludlow, L. H., & O'Connor, C. M. (2018). Does context matter? Convergent and divergent findings in the cross-institutional evaluation of graduate teaching assistant professional development programs. *CBE Life Sciences Education*, *17*(1), 1–13. https://doi.org/10.1187/cbe.17-03-0044
Sheppard, S., Macatangay, K., Colby, A., & Sullivan, W. M. (2009). *Educating engineers: Designing for the future of the field*. Jossey-Bass.
Stark, J. S. (2000). Planning introductory college courses: Content, context and form. *Instructional Science*, *28*, 413–438. https://doi.org/10.1023/A:1026516231429
Stark, J. S., Lowther, M. A., Ryan, M. P., & Genthon, M. (1988). Faculty reflect on course planning. *Research in Higher Education*, *29*(3), 219–240. https://doi.org/10.1007/BF00992924
Tan, C. M. (1992). An evaluation of the use of continuous assessment in the teaching of physiology. *Higher Education*, *23*(3), 255–272. https://doi.org/10.1007/BF00145016
Terenzini, P. T., & Reason, R. D. (2005). Parsing the first year of college: A conceptual framework for studying college impacts. *Annual Meeting of the Association for the Study of Higher Education*.
Toth, L. S., & Montagna, L. G. (2002). Class size and achievement in higher education: A summary of current research. *College Student Journal*, *36*(2), 253–261.
Vaessen, B. E., van den Beemt, A., van de Watering, G., van Meeuwen, L. W., Lemmens, L., & den Brok, P. (2017). Students' perception of frequent assessments and its relation to motivation and grades in a statistics course: a pilot study. *Assessment and Evaluation in Higher Education*, *42*(6), 872–886. https://doi.org/10.1080/02602938.2016.1204532
Wang, M. Te, & Eccles, J. S. (2013). School context, achievement motivation, and academic engagement: A longitudinal study of school engagement using a multidimensional perspective. *Learning and Instruction*, *28*, 12–23.

https://doi.org/10.1016/j.learninstruc.2013.04.002
Wang, X. (2013). Why students choose STEM majors: Motivation, high school learning, and postsecondary context of support. *American Educational Research Journal*, *50*(5), 1081–1121. https://doi.org/10.3102/0002831213488622
Wigfield, A., & Eccles, J. S. (2000). Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology*, *25*, 68–81. https://doi.org/10.1006/ceps.1999.1015
Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). Sage Publications.