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Individual and situational expectancy, value, and cost motivational beliefs at Hispanic-Serving Institutions

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ABSTRACT

Background: Following growing calls to investigate the situational nature of motivation across diverse institutional contexts and student populations, this study examined fluctuations in students' motivational beliefs–expectancy, value, and costs–across multiple time points in an introductory statistics course.
Aims: We aimed to replicate and extend prior work conducted at predominantly White/Asian institutions by exploring whether dynamic patterns of motivation generalize to Hispanic-Serving Institutions (HSIs), addressing the need for more inclusive research on situational motivation.
Sample: The sample consisted of 439 students enrolled in an introductory statistics and data science course at several HSIs.
Methods: Using an intensive longitudinal design, we measured students' motivational beliefs at multiple time points. We analyzed overall trajectories, within- and between-student variability, associations with course performance, and the moderating role of demographic factors.
Results: Consistent with past research, we found substantial within-student variability in motivational beliefs across expectancy, value, and cost. However, associations between motivation and performance, as well as demographic moderators, differed from those observed in prior studies conducted at predominantly White/Asian institutions.
Conclusions: Findings highlight the importance of examining motivation as a dynamic, context-dependent process. Results highlight the need for further research into how situational and contextual factors shape motivation and academic outcomes across diverse student populations and institutional settings.

1. Introduction

Motivation is a key factor for addressing access and success challenges in STEM fields (Robinson et al., 2019). Studies show that motivation is directly tied to students' academic performance, engagement, and well-being (Hidi et al., 2019). Decades of research reveal two key patterns: (a) motivation tends to decline over the long term - whether across a school year or from childhood through adolescence - and (b) motivation varies between students (see e.g., Eccles et al., 1993; Meece et al., 2009). Over the past two decades, situated perspectives (Nolen & Ward, 2008; Turner & Nolen, 2015) have reframed motivation as a dynamic process, meaning that students' motivational beliefs are not fixed traits but fluctuate in response to the immediate learning environment. From this perspective, motivation is context-sensitive and can vary across time, tasks, and situations depending on momentary factors such as the learning materials, instructional practices, and perceptions of classroom climate (Rosenberg et al., 2020). Despite this growing recognition, most research has focused on between-person differences while within-person investigations remain scarce. To date, no more than a dozen studies have examined within-person fluctuations in motivation constructs (Beymer et al., 2022; Dietrich et al., 2017; Kim et al., 2023; Sutter et al., 2024a). Expanding within-person research is crucial to advance motivation theory and better understand motivation in context, both of which can drive the translation of findings into practical

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interventions that support student engagement and persistence. Building on situative perspectives, the present study adopts a within-person approach to examine how students' motivational beliefs fluctuate over the course of a semester and across specific textbook chapters, uncovering the situated and dynamic nature of motivation in authentic classroom contexts.

While a growing number of studies have examined within-person variability in motivational constructs (e.g., Beymer et al., 2022; Dietrich et al., 2017; Kim et al., 2023), most have been conducted in homogeneous, predominantly White or Asian higher education settings and have relied on analytic approaches that capture short-term fluctuations (e.g., daily or lesson-level variability). In contrast, the present study extends this literature in two key ways. First, it examines within-person dynamics in a Hispanic-Serving Institution (HSI) context, where students' motivational experiences are shaped by distinct cultural and institutional factors that remain understudied in the literature. Second, our intensive longitudinal design (with eight repeated measures across a semester) captures within-student variability, offering a complementary view into how students' expectancy, value, and cost beliefs fluctuate throughout an academic semester rather than past work focused on variation across a specific lesson or day. This design allows us to explore whether previously observed patterns of within-person variability generalize to more diverse educational contexts and longer time frames. In particular, this study directly contributes to advancing situated expectancy-value theory by extending within-person analyses to racially and institutionally diverse contexts, an area that remains underexplored in existing motivation research. Thus, this work responds to broader calls for research that examines motivation in more diverse institutional and cultural contexts. Much of the existing research has focused on predominantly White and Asian-serving institutions, raising questions about the external validity and generalizability of these findings. Students from racially marginalized backgrounds, first-generation college students, and those enrolled in minority- or Hispanic-serving institutions may encounter distinct structural conditions (e.g., institutional resources, faculty representation) and bring diverse cultural values, prior experiences, and coping mechanisms that shape their motivational processes (Bowman et al., 2023, pp. 238–272; Hernandez et al., 2023). Within situated-expectancy-value theory (SEVT; Eccles & Wigfield, 2020), scholars have highlighted that the sociocultural context is integral to shaping expectancies and task values. A growing body of research grounded in this framework has documented differential motivational experiences from an SEVT lens among students from racially marginalized backgrounds (Perez et al., 2024; Rosenzweig & Wigfield, 2017; Sutter et al., 2022), showing that these students often experience lower success expectancy and task values as well as heightened perceived costs compared to their non-marginalized peers. However, most within-person approaches have yet to examine how these sociocultural and structural factors interact with students' momentary motivation, particularly for students at Hispanic-Serving Institutions, where such dynamics may differ. Yet, the direction and magnitude of these motivational differences may depend on the institutional context. Research grounded in cultural mismatch theory shows that racially and socioeconomically marginalized students may experience motivational disadvantages in contexts that privilege independence and individual achievement (Stephens et al., 2012). However, in institutions where students' cultural values align more closely with the educational environment, such as community colleges or Hispanic-Serving Institutions, this mismatch may be reduced. For example, Tibbetts et al. (2018) found that at 2-year colleges with stronger interdependent norms and greater representation of first-generation students, students reported greater value alignment and belonging, suggesting that institutional contexts emphasizing collaboration and community may buffer motivational disparities. Thus, whether differences in expectancy, value, and cost beliefs emerge in HSIs needs to be further explored. Recent calls therefore highlight the importance of exploring whether established motivational patterns extend to a broader range of student populations and educational settings (Lauermann, 2024; Törmänen et al., 2025).

Building on these calls, this study examines students' motivational beliefs at Hispanic-serving institutions, which also enroll large proportions of students from racially marginalized and first-generation college backgrounds. By shifting the research lens to this unique educational context, we aim to deepen our understanding of how students' motivational beliefs develop over time and vary *within* students. Specifically, this study tests key propositions of the situated expectancy-value (Eccles & Wigfield, 2020) and expectancy-value-cost (Barron & Hulleman, 2015) frameworks by:

(a) examining patterns in expectancy, value, and cost beliefs at Hispanic-serving institutions, and whether these patterns resemble those observed at predominantly White and Asian institutions;
(b) assessing how both individual differences (between-student variability) and situational factors (within-student fluctuations) contribute to changes in motivation over time; and
(c) exploring whether these motivational patterns are moderated by demographic characteristics, including racial/ethnic marginalization, first-generation college status, and gender.

2. Theoretical background

2.1. The contextual and dynamic nature of expectancy, value, and cost beliefs

Situated expectancy-value theory (Eccles & Wigfield, 2020; also see Barron & Hulleman, 2015 for the expectancy-value cost model of motivation) is a foundational framework for understanding student motivation. This theory posits that students' achievement-related choices and performance are most proximally determined by students' success expectancy, subjective task values, and perceptions of cost. Success expectancy refers to students' perception of or their confidence in their ability to do a given task. Task values refer to the reasons why and the extent to which a student wants to complete a given task including perceived relevance of a task to their sense of self, identity or personal values (i.e., attainment value), perceived enjoyment and interest from engaging in a task (i.e., intrinsic value), and perceived usefulness and relevance for current or future goals from engaging in a task (i.e., utility value; Eccles et al., 1983; Eccles & Wigfield, 2002). Cost refers to students' perceived negative consequences of engaging in that task (e.g., the effort, time, and/or negative emotional costs required by a task or opportunities that are lost because of the engagement in the task; see Flake et al., 2015; Perez et al., 2014).

Together, expectancy, value, and cost beliefs offer a comprehensive framework to explain why students engage (or don't engage) in academic tasks. Further, abundant empirical research shows that expectancy, value, and cost are each meaningfully linked to student outcomes. Specifically, success expectancy tends to predict achievement outcomes (e.g., course grades), while value beliefs more strongly predict interest and choice outcomes(e.g., persisting in a degree program or enrolling in additional courses in a subject; Guo et al., 2017). Although cost has received less attention, recent studies indicate that perceived costs also significantly predict both performance and choice (Jiang et al., 2018; Perez et al., 2019).

Expectancy, value, and cost beliefs are in turn shaped by various factors. Aligned with Nolen and colleagues' situated views of motivation (Nolen et al., 2015; Turner & Nolen, 2015), expectancy, value, and cost beliefs are sensitive to context and depend on dynamic, momentary factors. For example, learning materials or teaching practices emphasizing the value of making mistakes as part of the learning process can increase students' confidence in their abilities (i.e., their success expectancy). Similarly, a student's interest (i.e., intrinsic value), within a course might vary depending on the specific topic being covered. For example, if instructional activities incorporate real-world examples of

course topics and allow students to connect these topics to their personal interests, they can enhance students' perceptions of the usefulness, practical relevance, and value of the content (Hulleman et al., 2025; Totonchi et al., 2023). Therefore, these beliefs not only vary between students - shaped by individual factors such as prior achievement, cultural background, and personal goals - but also vary within each student, depending on contextual/situational influences like task framing. Although still scarce, recent research provides evidence for within-student variability in expectancy, value, and cost beliefs across educational context. For example, in a teacher-education program, Dietrich et al. (2017) tracked students' expectancies and task values over a semester and found systematic lesson-to-lesson fluctuations that aligned with perceived instructional quality. In secondary-school mathematics, Parrisius et al. (2022) found that students' situation-specific competence and value beliefs varied from class to class and were predicted by momentary perceptions of autonomy-supportive teaching. Similarly, Beymer et al. (2022) documented within-person variability in value and cost across activities in science classrooms, and Kim et al. (2023) observed comparable patterns of motivational change across a semester in undergraduate psychology. Finally, Sutter et al. (2024a) found that students' expectancy, value, and cost beliefs fluctuated across textbook chapters in an introductory statistics and data science course and that these within-student fluctuations predicted performance. Collectively, these studies underscore that motivational beliefs are not fixed traits, but dynamic, context-sensitive states shaped by immediate learning experiences. Yet, because most existing work has been conducted among White/Asian and Western samples, relatively little is known about such within-person changes in more diverse, minority-serving higher education settings – an important gap the present study seeks to address.

2.2. Situational motivation and performance: The moderating role of marginalized backgrounds

Depending on the situation, motivational beliefs may have stronger or weaker relations to academic outcomes. In fact, it may be that situational fluctuations in motivation work alongside stable personal characteristics to influence how motivation affects performance. This may be especially true for racially marginalized, first-generation college, and female students, whose motivation and performance could be affected by identity threats when they are in situations where the norms involve majority male, White, and high-socioeconomic status STEM environments including statistics and data science (Shapiro & Williams, 2012).

For example, Sutter et al. (2024a) found that the relationship of situational expectancy and utility value with performance was stronger for students from racially marginalized backgrounds than for White/Asian students. Their findings align with theories such as stereotype threat (Steele & Aronson, 1995) and cultural mismatch theory (Stephens et al., 2012), which suggest that students from marginalized backgrounds may experience additional psychological burdens or conflicting norms in learning environments that were not designed with their experiences in mind. As such, these students may be more conscious of and sensitive to the cues they receive from their context and therefore may be more influenced by their learning environment. While this recent finding highlights the importance of context for students from racially marginalized backgrounds, this prior work has largely been conducted in highly selective, predominantly White and Asian institutions. There is a notable lack of research exploring whether these patterns hold in other educational contexts, such as Hispanic-serving institutions, where students from racially marginalized and underserved backgrounds comprise the majority. The present study addresses this gap by examining whether students' racially marginalized background, their college generation status, and gender moderates the relationship between situational motivation and performance in these more representative settings.

3. The present study

Building on prior work conducted in predominantly White and Asian institutions, the present study extends this line of research on situational motivation by examining motivational processes within Hispanic-serving institutions. Our goal is to explore whether the same motivational patterns - particularly the role of situational variability and its impact on performance - hold for students from historically marginalized backgrounds in different institutional contexts. Specifically, the following research questions - which align with prior research at a highly selective, predominantly White and Asian institution (Sutter et al., 2024a) - guided our study:

(1) How do expectancy, value, and cost change over the course of the term?
(2) How much of the variability in expectancy, value, and cost can be attributed to individual (between-student) and situational (within-student) sources?
(3) How does individual (between-student) and situational (within-student) variability in expectancy, value, and cost predict variability in performance?
(4) To what extent do student demographic characteristics (racially marginalized status, college generation status, and gender) moderate the relationship between motivational beliefs and performance at the individual (between-student) and situational (within-student) levels?

4. Methods

4.1. Context and participants

This study was approved by the Institutional Review Board at the University of California, Los Angeles (IRB No: 20-001033) as part of a larger ongoing project to continuously improve an online interactive statistics and data science textbook (available for preview at anonymized for peer review). All students in our sample (n = 439) were enrolled in college courses at two different Hispanic Serving Institutions in the western United States that operate on a semester system and share an overarching educational mission to advance educational equity, social mobility, and community engagement for diverse and historically underrepresented student populations. Both institution's missions prioritize diversity, inclusion, and access, which likely shapes the institutional culture surrounding teaching and learning. Within this context, the participating courses used the 13-chapter interactive online textbook as part of their course. The textbook introduces foundational concepts in statistics and data science, including R programming, data visualization, descriptive statistics, introductory modeling, and inferential techniques. While the textbook emphasized applications to research in psychology, it is used by students across a range of majors. It embeds interactive exercises, formative assessments, and motivation surveys that provide continuous feedback for both instructors and researchers to support iterative curriculum improvement. The course structures typically included instructor-led labs, peer discussions, and group-based data analysis activities (e.g., working in Jupyter notebooks using real-life datasets), promoting a collaborative learning environment.

Of the students reporting their demographics, 77 % identified as female and 77.5 % identified as Latinx/Hispanic, 10.3 % as Asian/Asian American, 5.5 % as White, 1.2 % as Middle Eastern, .9 % as American Indian/American Native, .9 % as Native Hawaiian/Pacific Islander, and 4.6 % self-described their race as other and provided open-ended responses. When possible, these responses were reviewed and coded for underrepresented racially marginalized status. In total, roughly 85 % identified as belonging to a racially marginalized group, and 72.3 % were first-generation college students. These numbers are representative of the overall student body demographics of these institutions.

4.2. Measures

4.2.1. Situational expectancy, value, and cost beliefs

Starting with chapter 2, each chapter began with "pulse check" measures, in which students reflected on their success expectancy ("I am confident in what I have learned in the previous chapter"), intrinsic value ("I think the previous chapter was interesting"), utility value ("I think what I have learned in the previous chapter is useful") and cost ("I was unable to put in the time needed to do well in the previous chapter") on a six-point Likert scale from 1 (*strongly disagree*) to 6 (*strongly agree*).[1] Acknowledging the limitation of single item measures, we've previously established and reported on construct validity for these chapter-level pulse checks with their longer, multi-item measures collected during the academic term (Authors et al., 2024a). Although these are single-item measures, we have previously established evidence of their construct validity by demonstrating strong correlations with multi-item scales administered at multiple points during the academic term (Sutter et al., 2024a). Single-item indicators are commonly used in research on situational motivation to reduce participant burden and capture dynamic, state-like constructs (e.g., Gogol et al., 2014). However, an important limitation is that measurement error cannot be estimated separately from true score variance. Accordingly, our estimates of situational variability necessarily include some unknown proportion of non-systematic variance attributable to measurement error.

4.2.2. Performance

Students' end-of-chapter review question scores (calculated as proportions based on the number of points earned divided by the number of points possible) were used as an indicator of performance. In the version of the textbook used by students in this study, only Chapters 1 through 9 included end-of-chapter review question scores.

4.3. Analyses

4.3.1. Modeling strategy

Because our research questions center on the situated nature of motivation within SEVT, we used multilevel modeling (MLM) to separate variation in motivational beliefs into within-student (situational) and between-student (individual differences) components. MLM is well suited for this design because it accounts for the nested structure of repeated measures within students and allows us to estimate fluctuations in students' motivation over time as a function of chapter-level context. This analytic approach aligns with recent calls in motivation science to examine within-individual/intraindividual variability as a theoretically meaningful source of information rather than statistical noise (Marsh et al., 2020; Pekrun & Marsh, 2022). By specifying time at Level 1 and students at Level 2, our models estimate both situational variability and individual differences in motivational trajectories across the course.

To examine how expectancy, value, and cost beliefs changed over time (RQ1), we used MLM to estimate both linear and quadratic trends in motivational beliefs across chapters, with repeated measures nested within students. To model within- and between-student variability in motivation (RQ2), we used multilevel models with chapters nested within students (Level 1 = timepoint/chapter; Level 2 = student). That is, situational variability was calculated using chapter-level variance, and individual differences using student-level variance. We also computed intraclass correlations (ICCs) to quantify the proportion of variance attributable to between-student differences. To examine the predictive role of motivational beliefs on performance (RQ3), we estimated MLMs in which both chapter-level (within-student) and aggregated (between-student) motivational scores predicted performance (i.e., end-of-chapter review question scores). Both univariate and joint models were estimated to assess the unique predictive contributions of each motivational variable. To explore the potential moderating role of student demographics (RQ4), we added underrepresented racial marginalized background, first-generation college status, and gender to the models as Level 2 predictors. These extended models also included interaction terms to test whether the relationship between motivation and performance varied across student groups. Descriptive analyses were conducted in SPSS (version 31) while the multilevel models were estimated in Mplus (version 8.6).

4.3.2. Scope of analysis and missing data analysis

To align motivation and performance data, we limited all analyses to timepoints 2 through 9, as motivation variables were not assessed in chapter 1 and review question scores were not available after Chapter 9. Despite this, substantial missing data remained among the chapter-level assessments (range: 4.1 %–67.5 %; median of 28.1 %). Missingness was unrelated to racially marginalized background, generation status, or gender (all p's $> .05$), but varied by chapter (see Fig. 1). The concordance of missingness across measures suggests students tended to complete or skip all assessments within a chapter, indicating general attrition rather than selective responding. Most attrition occurred after a certain point in the course, with some students returning for Chapter 9. This pattern raises concerns that the data might be missing not at random (MNAR; Enders, 2022, p. 11), in that the likelihood of attrition may be related to the unobserved scores students would have obtained had they completed the assessments. To address this, we used multiple imputation with motivation and performance scores from earlier chapters as auxiliary variables, serving as proxies for the missing assessments. Including such variables can render data conditionally missing at random (Enders, 2022, p. 133), making multiple imputation appropriate (Peugh & Enders, 2004). Additionally, we conducted follow-up analyses that estimated the same multilevel model separately for students who completed all nine chapters (completers) and those who did not (non--completers). This multiple-group approach allows us to examine whether parameter estimates differ by completion status, providing a practical sensitivity check for potential nonrandom attrition (Enders, 2022, p. 351). Similar estimates across groups would suggest that attrition-related missingness had little influence on the results.

5. Results

5.1. How do expectancy, value, and cost change over the course of the term (RQ1)?

To address the first research question, we started with a graphical examination of the expectancy, value, and cost means for each chapter (see Fig. 2; also see Supplemental Table S1 for descriptive statistics by chapter).

Based on this graph, we decided to test both the linear and quadratic trends of change in motivational variables using MLMs. In these models, measurements of motivation in each chapter (Level 1) were nested within students (Level 2). At Level 1, our MLM estimated a polynomial equation relating chapter number to motivation for each student. This method allowed us to investigate how motivational beliefs change as chapter numbers increase (i.e., as students progress through the chapters). This equation contained an intercept, a linear coefficient, and a quadratic coefficient. These coefficients were then included as random coefficients at Level 2, enabling us to determine the mean linear and quadratic effects (averaging over students) as well as the extent to which these effects varied between students (see Curran & Bauer, 2011).

The results of our analyses (see Table 1) indicated that, on average, expectancy ($b = -.056$, SE $= .018$, $p = .002$), intrinsic value ($b = -.115$,

[1] Because the surveys were embedded directly into the curriculum, we limited them to four questions to minimize survey fatigue. We did not include attainment value. Instead, we focused on intrinsic and utility value, which are more likely to fluctuate throughout the course and appear more amenable to classroom-based interventions (Hulleman et al., 2010, p. 891).

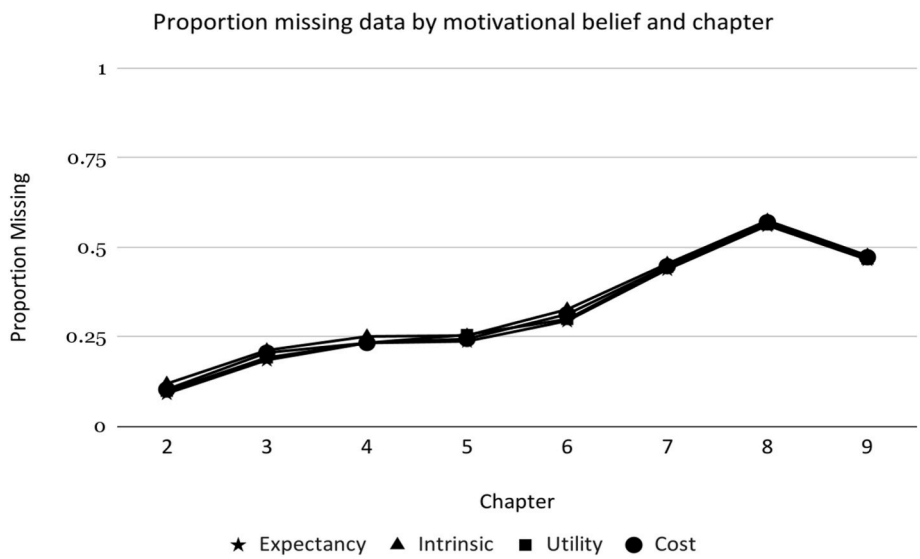

Fig. 1. Proportion missing data by measure and chapter.

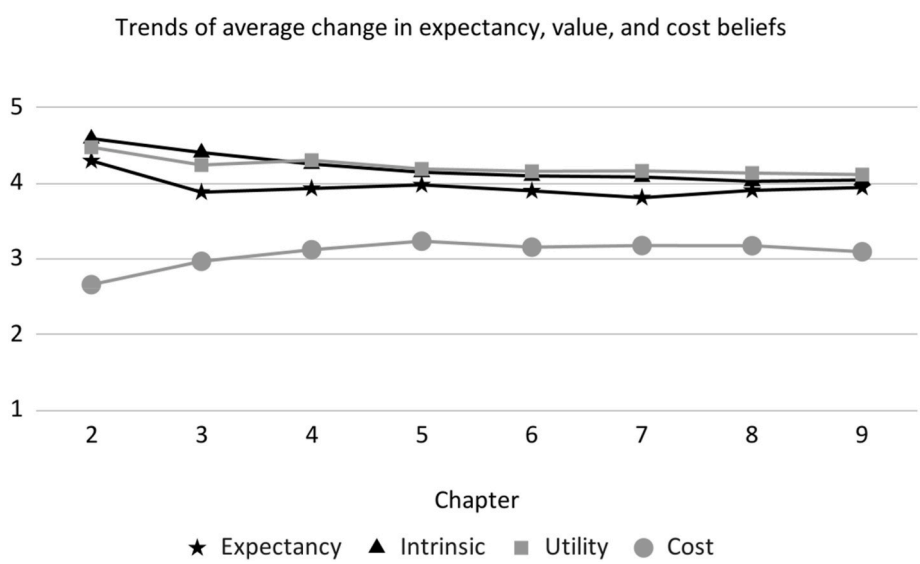

Fig. 2. Trends of change in averaged expectancy, intrinsic and utility value, and cost by chapter.

Table 1
Mean and variance of linear and quadratic trends in motivation across students.

	b (SE), *p*			
	Expectancy	Intrinsic Value	Utility Value	Cost
Linear mean	−.056 (.018), $p = .002$	−.115 (.016), $p < .001$	−.066 (.015), $p < .001$	.092 (.022), $p < .001$
Linear variance	.037 (.011), $p = .001$	.040 (.010), $p < .001$	.033 (.009), $p < .001$	.150 (.015), $p = .001$
Quadratic mean	.067 (.017), $p < .001$	.077 (.016), $p < .001$	.042 (.015), $p = .006$	−.099 (.021), $p < .001$
Quadratic variance	.004 (.007), $p = .581$	.011 (.008), $p = .159$	.008 (.007), $p = .280$	.009 (.011), $p = .393$

SE = .016, $p < .001$), and utility value ($b = -.115$, SE = .016), $p < .001$) declined linearly while cost ($b = .092$, SE = .022, $p < .001$ increased linearly as students progressed through the chapters. The mean linear components indicate the average rate at which motivation beliefs changed over the course of chapters. Additionally, the linear change in all four motivational beliefs varied significantly between students. That is, different students experienced varying rates of decline in their expectancy, intrinsic value, and utility value, and varying rates of increase in their cost. Further results suggested that all four motivational beliefs also had significant quadratic trends. The mean quadratic components indicate the acceleration of change in motivation beliefs as students progress through the chapters (Biesanz et al., 2004). The positive signs for the quadratic means for expectancy ($b = .067$, SE = .017, $p < .001$), intrinsic value ($b = .077$, SE = .016, $p < .001$), and utility value ($b = .042$, SE = .015, $p = .006$) indicated an upward curvature, suggesting that on average these beliefs initially declined and then levelled out. The negative sign for the quadratic mean for cost ($b = -.099$, SE = .021, $p < .001$) indicated a downward curvature suggesting that on average this belief initially increased and then levelled out. The quadratic trends did not significantly vary between subjects.

5.2. How much variability in motivation is due to individual vs. situational factors (RQ2)?

The ICC results (see Table 2) indicated that roughly 40–55 % of the variance was due to individual (between-student) differences and the remainder was due to situational (within-student) variability. Therefore, contradicting the conventional approach that only focuses on individual (between-student) differences, the results indicated the presence of substantial situational (within-student) variability in all the variables, highlighting the importance of examining motivation at both the individual and situational levels.

5.3. How does motivation predict performance at the individual and situational levels (RQ3)?

We found substantial correlations among expectancy, value, and cost at both the individual and situational levels (see Supplemental Table S2). To understand the effects of multicollinearity and determine whether individual or situational variability better predicts performance, we estimated models both separately and jointly for each motivational construct. Table 3 presents the pooled coefficients: the first columns show bivariate relationships with performance, while the "joint" column reflects their combined predictive value.

These results show that when examined individually, expectancy ($b = .038$, SE = .013, $p = .003$) and cost ($b = -.056$, SE = .014, $p < .001$) were related to performance at the individual (between-student) level, while utility value ($b = .014$, SE = .006, $p < .013$) was related to performance at the situational (within-student) level. Averaging over chapters, students with higher overall expectancy also had higher overall performance, while students with higher overall costs also had lower overall performance. The significant effect of utility value at the within-student level suggests that in chapters where students reported higher utility value, they also had higher performance. The overall pattern of results was replicated in the joint model.

We conducted follow-up analyses that estimated the same multilevel model separately for students who completed all nine chapters (completers) and those who did not (non-completers) The coefficients comparing the coefficients for the completers and non-completers are presented in Supplemental Table S2. None of the individual or situational relationships of the motivation assessments with performance observed among non-completers were significantly different from those observed among completers (all p's $> .05$). We did not observe any evidence that MNAR processes influenced our results.

5.4. Do demographic characteristics moderate the motivation–performance relationship (RQ4)?

We ran a final set of models including racially marginalized status, first-generation status, and gender as Level 2 predictors of both overall performance and the motivation–performance relationships. Each motivational variable was tested separately and jointly to assess the impact of multicollinearity (see Supplemental Table S3 for full results).

In the models examining expectancy, value, and cost separately, none of the demographic characteristics significantly influenced the relations of the motivation assessments to performance at the situational (within-student) level (all p's $> .05$). At the individual (between-student) level, gender significantly moderated the relationship of expectancy with performance ($b = .084$, SE = .034, $p = .015$), such that the relationship of expectancy with performance was positive for females ($b = .058$, SE = .015, $p < .001$) but non-significantly negative for males ($b = -.025$, SE = .029, $p = .388$). This result suggests that averaging across all chapters, having strong expectancy beliefs would positively and favorably predict performance for female students but not for male students. A similar moderator pattern also appeared for intrinsic value ($b = .062$, SE = .031, $p = .044$), where the relation of intrinsic value with performance was again positive for females ($b = .034$, SE = .014, $p = .015$) but non-significantly negative for males ($b = -.028$, SE = .027, $p = .291$). Gender did not influence the effects of utility value or cost with performance at the individual level (both p's $> .05$). Racially marginalized background and first-generation status did not influence the relations of motivation with performance at either the situational or individual levels (all p's $> .05$). While the effect of gender on the relationship of expectancy with performance replicated in the joint model (b = .104, SE = .051, $p = .041$), the effect of gender on the relationship of intrinsic value with performance did not (b = .042, SE = .054, $p = .429$). This suggests that the effect of gender on the relationship of intrinsic value with performance could have resulted from collinearity with other interaction effects (such as the gender by expectancy interaction).

Table 2
Individual (between-student) and situational (within-student) variability in study variables.

Variable	Individual (between-student) variance	Situational (within-student) variance	Intra-class correlation
Expectancy	.617	.672	.478
Intrinsic value	.669	.583	.534
Utility value	.633	.509	.555
Cost	.647	1.006	.391
Performance	.031	.026	.544

Table 3
Unstandardized coefficients from models predicting performance from expectancy, value, and cost.

	b (SE), p				
	Expectancy	Intrinsic Value	UtilityValue	Cost	Joint
Within					
Expectancy	.004 (.005), $p = .442$				−.004 (.006), $p = .528$
Intrinsic Value		.007 (.006), $p = .218$			−.001 (.007), $p = .448$
Utility Value			.014 (.006), $p = .013$		.016 (.007), $p = .026$
Cost				.000 (.005), $p = .955$	.000 (.005), $p = .960$
Between					
Expectancy	.038 (.013), $p = .003$				.052 (.019), $p = .007$
Intrinsic Value		.017 (.012), $p = .164$			−.001 (.023), $p = .967$
Utility Value			.017 (.013), $p = .178$		−.029 (.025), $p = .243$
Cost				−.056 (.014), $p < .001$	−.050 (.014), $p < .001$

6. Discussion and significance

In line with calls to investigate the situational nature of motivation across different student populations and educational contexts, our research across two Hispanic-serving institutions highlights three key findings: (1) Expectancy, intrinsic value, and utility value declined during the term while cost increased - especially early on - before leveling out mid-semester, with substantial variation across students; (2) All four motivational beliefs examined in this study showed substantial within-person variability that can be attributed to situational factors;

this variability is often overlooked in motivational theories and empirical research; (3) Not only do motivational beliefs vary both between- and within-students; they do so to different degrees and they also differ in how strongly they predict performance at both the individual and situational levels. Below, we discuss the implications of these findings for theory, research, and practice.

6.1. Expectancy, value, and cost trajectories over time

The findings that expectancy, intrinsic value, and utility value declined - while cost increased - most sharply early in the term before leveling out mid-semester, with substantial variation across students, highlight the dynamic and context-sensitive nature of motivation in statistics and data science courses. These patterns mirror broader trends documented in STEM education (Benden & Lauermann, 2022; Sutter et al., 2022, 2024a; Kosovich et al., 2017; Robinson et al., 2019), but the curvilinear trajectory suggests that changes in motivation are not uniform across time. Motivation appears to decline most steeply at the beginning of the term, then stabilizes as the semester progresses. This leveling off may reflect shifts in students' perceptions as the term's end approaches, which may bring a sense of relief and lower perceived costs. These findings point to the need of identifying when students are most vulnerable to motivational dips and timing interventions strategically, particularly in the early weeks of the course. The substantial variability across students further affirms the need to disaggregate motivational trajectories and tailor support to individual needs. These patterns can also be understood in light of the institutional context, namely the Hispanic Serving Institutions in which this research took place. As evidenced by their institution's mission statements, both HSIs are characterized by a strong emphasis on community, inclusion, and diversity, which may shape how students experience and respond to motivational challenges (Núñez et al., 2015). Features such as greater representation among peers and faculty, institutional missions and policies that prioritize access and equity, as well as on-campus support systems may all contribute to the observed motivational dynamics. Such contexts may promote a sense of belonging or normalize academic struggles, potentially buffering students from experiencing sharp motivational declines.

More broadly, the results reinforce that motivation is not a fixed trait, but a dynamic process shaped by evolving expectations, contextual cues, and the structure of the learning environment - highlighting the potential for intentional course design to sustain or even rekindle students' engagement over time.

6.2. Individual vs. situational variability in expectancy, value, and cost

The finding that the motivational beliefs showed substantial within-person variability reinforces and extends the application of situated expectancy-value theory (Eccles & Wigfield, 2020), affirming that expectancy, value, and cost are not static traits, but can be dynamic experiences shaped by moment-to-moment interactions with instructional content and context. This finding aligns with recent calls to consider both individual differences and dynamic, context-sensitive changes in motivation, providing evidence that within-student variation in motivation is consistent across different educational contexts and student populations.

The considerable situational variability in motivational beliefs underscores the need to consider how instructional and curricular design might differentially impact students' motivation from week to week or chapter to chapter, especially in gateway STEM courses where motivation is already vulnerable to decline (Sutter et al., 2022, 2024a; Robinson et al., 2019). The intraclass correlation coefficients (ICCs; which indicate the proportion of variance attributable to between-student differences versus within-student fluctuations; see Fig. 3) for expectancy, intrinsic and utility value in this study replicate prior work in introductory statistics (Sutter et al., 2024a) with very similar values. However, they are higher than those reported by Berweger and colleagues (2022) in the context of an Educational Science program, suggesting they are more stable across students in the present context. In contrast, the ICC for perceived cost was substantially lower than in both prior studies (Sutter et al., 2024a; Berweger et al., 2022), indicating that perceived costs for the students in our sample were perhaps more situational and context-dependent than previously observed. This finding provides support for situated expectancy-value theory's core premise that both context and identity matter and suggests that these processes may manifest differently in different institutional settings. It is important to note, however, that estimates of situational variability in this study necessarily include an unknown proportion of non-systematic variance due to measurement error. Because our models relied on observed, single-item indicators rather than latent variables, we were unable to separate true within-student fluctuations from random error. This limitation does not undermine the interpretation of meaningful situational variability but suggests that our ICC estimates may be somewhat attenuated and should be interpreted as upper-bound estimates of true situational effects. Differences in measurement precision across studies may also contribute to variation in ICC estimates reported in prior research.

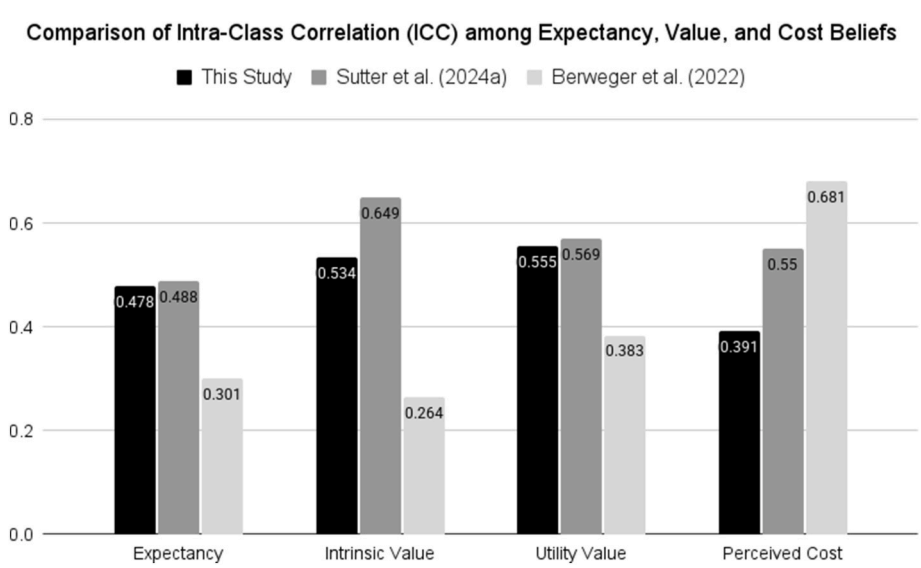

Fig. 3. Intra-class correlation coefficient comparison among expectancy, intrinsic and utility value, and cost.

In fact, out of all the motivational beliefs explored in this study, perceptions of cost had the highest within-student variability. This high variability may indicate that perceived costs are particularly sensitive to the nature and demands of each chapter (e.g., cognitive load, time commitment, difficulty, length etc.). In other words, cost may reflect students' moment-to-moment struggles with content complexity or workload more so than enduring beliefs about the course. However, it's also important to consider the wording of the cost item itself: "I was unable to put in the time needed to do well in the previous chapter." Perhaps rather than capturing perceptions of the curriculum or coursework as burdensome, this phrasing may reflect students' external constraints (e.g., work, family, or other obligations), which are often particularly salient for students at Hispanic-serving institutions (see e.g., Garcia, 2019). In this context, high variability in cost may stem not just from the instructional material itself but from the dynamic interaction between the course and students' broader life demands. For Hispanic students in particular - who often face shifting responsibilities related to work, family, or other obligations - perceived cost may fluctuate from week to week depending on what life requires of them at that moment. One week, students may be able to fully engage with the material; the next, they may struggle to find time due to competing demands. Thus, the elevated within-student variability in cost may reflect real-time changes in students' lived experiences, highlighting the importance of interpreting cost as a motivational belief that is both situated and sensitive to temporal context, especially for students navigating multiple roles and responsibilities. Future research should - similar to Kim et al. (2023), consider different dimensions of cost (e.g., effort cost, emotional cost, opportunity cost) to gain a more fine-grained understanding of how each type of cost operates and fluctuates across different situations.

In contrast to perceived cost, intrinsic value and utility value showed relatively low within-person variability. In our particular context, it is possible that the low situational variability reflects successfully embedded value messages throughout the curriculum. The textbook, by design, aims to maintain consistently high levels of relevance and value across the course through real-world examples and datasets, which may buffer students' value beliefs, making them less susceptible to fluctuation across chapters. Future research should explore whether similar patterns emerge across different populations and instructional settings. Together, these considerations highlight the importance of sample context in interpreting situational fluctuations in motivation. They also reinforce recent calls (e.g., Lauermann, 2024; Pekrun & Marsh, 2022) to pay greater attention to the temporal granularity of motivational assessments and to incorporate task- or chapter-level measurement when studying motivation in real instructional settings.

6.3. Motivational predictors of performance at the between-and within-student level

We found that the motivational beliefs operate differently at the individual and situational levels. At the individual, *between*-student level, expectancy was positively and cost negatively related to overall performance - a pattern that held in both the bivariate and joint models and is consistent with the theoretical expectation that enduring self-beliefs and perceived barriers shape performance outcomes. However, *within* students, only utility value predicted performance - again, a pattern that held in both the bivariate and joint models. Specifically, students performed better in chapters they perceived as more useful. This finding may reflect that for students at Hispanic-serving institutions, immediate perceived usefulness of content is a particularly salient motivational driver and that students' appraisals of utility value may be more reactive to the immediate content. This chapter-level coupling of perceived utility and performance highlights the importance of designing instructional materials that encourage students to make connections between what they are learning and the real world and that more broadly ensure that students repeatedly see value connections in each chapter.

Interestingly, our results pertaining to within-student variability in motivation and its relation to performance contrast findings of other within-student relations observed in a previous study at a Predominantly White Institution (Sutter et al., 2024a) that found significant relations between expectancy or intrinsic value with performance) suggesting that motivational processes may operate differently across institutional contexts. It is possible that within-student fluctuations in expectancy or interest are less tied to immediate performance in Hispanic-serving institutions. One potential explanation could be that Hispanic-serving institutions offer students a greater sense of identity safety, reducing the salience of situational cues that would otherwise influence motivation-performance dynamics. In more identity-threatening environments (like Predominantly White Institutions), fluctuations in expectancy might more directly affect performance because students feel they are under scrutiny or do not belong (e.g., Steele & Aronson, 1995). In contrast, students at Hispanic-serving institutions may be more likely to view temporary setbacks as normal or shared experiences, which in turn dampens the performance consequences of lower expectancy or interest in a given chapter.

Finally, the lack of predictive power of cost on performance at the situational level replicates prior findings (Sutter et al., 2024a) and is consistent with the hypothesis underpinning expectancy-value theories (Eccles, 2009) that perceived cost is less strongly tied to achievement and performance than, for example, to choice intentions (Perez et al., 2014). Indeed, prior research has shown that different types of cost (such as task effort cost, opportunity cost, and psychological or emotional cost; Flake et al., 2015) relate differentially to students' academic decisions. For example, while perceiving the effort required or the sacrifices needed to succeed in a STEM major predicted greater intentions to leave, stress-related psychological costs did not (Perez et al., 2014). These findings suggest that not all costs weigh equally on students' choices, and that the perceived worthwhileness of effort (Perez et al., 2014) may be a particularly decisive factor. In our context, it may be that perceptions of cost only begin to impact performance when they cross a certain threshold. That is, although perceived costs fluctuate from chapter to chapter, their link to performance may not be linear. Instead, cost may have little impact until it overwhelms students' capacity to persist and perform—aligning with the idea that costs exert strong negative effects only when they outweigh the perceived value of the task (Perez et al., 2014). To extend this line of inquiry, the first author of the current study successfully collaborated with curriculum developers to add a second cost item - a psychological cost item - to the pulse checks embedded in each chapter of the textbook. Data collection with this measure is set to begin soon, enabling future research to further disentangle how different types of perceived cost shape performance.

6.4. Moderating role of student demographics in the motivation–performance relationship

While prior work conducted at Predominantly White Institutions (e.g., Sutter et al., 2024a) suggests that marginalized students may be more sensitive to contextual cues, our findings revealed that all students regardless of race, generation college status, or gender showed similar situational links between motivational beliefs and performance. In other words, student demographics did not moderate situational (within-student) relations between motivation and performance. This points to the possibility that students' experiences of representation or belonging at Hispanic-serving institutions may buffer some of the identity-related threats known to affect motivation in Predominantly White contexts (Shapiro & Williams, 2012). At HSIs, students from racially marginalized and first-generation backgrounds may not be numerical minorities, which can reduce stereotype salience (Steele, 2010). The broader institutional mission of HSIs (to advance equity, inclusion, and social mobility) often translates into campus climate that affirm students' cultural identities and provide social and academic support structures (Nuñez et al., 2015). Such environments may normalize

help-seeking and frame challenges and perceived costs as a shared experience (rather than an individual deficit). These cultural and structural affordances might create conditions that support more stable motivational trajectories across demographic groups, contributing to relatively equitable motivation-performance patterns observed in this study. Further research is needed to understand (a) whether being well-represented in terms of race (i.e., 77.5 % Hispanic) and generation status (i.e., 72.3 % first-generation) shapes how the learning context affects students' motivation and academic outcomes, and (b) the specific contextual and situational factors that explain within-person variability (Lauermann, 2024) and lead to differential outcomes for students from different demographic groups.

However, at the individual, between-student level, gender moderated the relationships between expectancy and performance as well as between intrinsic value and performance: female students who reported higher expectancy and higher intrinsic motivation performed better across the term, whereas these relations were nonsignificant for male students. This finding is inconsistent with prior work at Predominantly White institutions, which found that at the individual (between-student) level, the relation of expectancy with performance was stronger for male students (Sutter et al., 2024a). This finding suggests that female students may benefit more from strong motivational beliefs in Hispanic-serving institution contexts, perhaps due to different patterns of engagement with the learning environment. Future research should adopt an intersectional lens to examine how overlapping social identities shape both students' motivational trajectories and the extent to which these beliefs predict academic performance. In doing so, person-centered or qualitative approaches may be especially valuable for capturing how intersecting identities shape motivational experiences and achievement within Hispanic-Serving Institutions.

Overall, our findings offer several practical takeaways for instructors and curriculum designers, particularly at Hispanic-serving institutions. Given the substantial within-student variability in motivational beliefs - particularly cost - it is essential to move beyond static models of student motivation and adopt a situationally adaptive approach to curriculum design. This requires rethinking the traditional textbook model. In most cases, once textbooks or course materials are released, they remain unchanged for years, if not decades. CourseKata, by contrast, offers a dynamic, online interactive textbook that is continuously revised and improved based on real-time student data and instructor feedback. It is infused with authentic, real world examples and datasets helping students see the relevance of statistics and data science beyond the classroom, supporting utility value. To build success expectancy, the textbook includes coding scaffolds, error messages with encouraging feedback, and opportunities to re-run code, normalizing mistakes as part of the learning process. To help lower perceived cost, the platform incorporates design features such as anchor examples that students can revisit to reduce cognitive load, as well as messaging that normalizes challenges and emphasizes that the workload is manageable. As noted earlier, the curriculum team has already leveraged embedded pulse checks to identify chapters where students struggle and make timely adjustments - such as modifying pacing or restructuring content (see Sutter et al., 2024b). This reflects a continuous improvement model, where motivation data is not merely collected but actively used to guide iterative enhancements to curriculum and pedagogy. We believe this approach represents a practical application of situated motivation theory - acknowledging that motivation is shaped by moment-to-moment experiences and responding accordingly through system-level changes. Taken together, the findings of the present study - combined with the continuous improvement science approach behind the curriculum used by students in the present study (Stigler et al., 2020), where researchers, instructors, and curriculum developers collaborate to co-create and iteratively refine learning materials - highlight the potential of shifting the focus from changing or "fixing" students to changing or "fixing" the systems in which they learn and instructional materials and practices being used. Rather than viewing motivational dips as student deficits, this approach emphasizes improving instructional design, pacing, and contextual relevance to better support all learners.

Aligned with this situational approach, the chapter-level pulse checks can also function as diagnostic tools to identify "hot spots" - chapters where motivation dips - so instructors and curriculum developers can respond with targeted supports or revisions. In collaboration with the curriculum developers of Coursekata, we have also added a new pulse check item for an upcoming textbook release: "The previous chapter was stressful for me". This item assesses chapter-specific sources of perceived (psychological) cost, a facet we have not yet captured. It may also be important, however, to acknowledge and normalize fluctuations in student motivation to reduce stigma and foster persistence. Adding messaging in the textbook, normalizing that there may be harder chapters, where students will have to challenge themselves, could be beneficial.

Overall, this study supports situated views of motivation by showing that both between- and within-person variability in motivational beliefs can predict performance. Although these findings are likely closely tied to the specific textbook and curriculum used, they point to the broader takeaway that instruction should adapt to students' fluctuating motivational needs and states. The findings also raise a key question: If motivation is inherently shaped by the immediate learning context, to what extent can we expect motivational processes to replicate across studies that, by their very nature, occur in different contexts? As calls for replication efforts grow, this tension highlights the need for a more nuanced understanding of how institutional, cultural, and curricular contexts shape students' moment-to-moment experiences. In that sense, our findings may be context-specific (reflecting the particular features of the HSIs and the specific curriculum) but not context-bound (the motivational dynamics could theoretically be applicable to other learning contexts that share similar structural and pedagogical features). Although we did not directly measure institutional or cultural mechanisms such as belonging or representation, theory and prior research suggest that features commonly associated with HSIs (e.g., community orientation, inclusive pedagogy, and missions centered on access and equity) may foster conditions that support motivation more equitably across students. For practitioners, the broader implication is that motivation is best supported when learning environments are culturally responsive and adaptable, recognizing that students' motivational experiences are dynamic, situated, and intertwined with the contexts in which they learn.

7. Limitations & future research

While we intentionally sought to explore patterns across different institutional contexts by extending prior work at Predominantly White Institutions (e.g., Sutter et al., 2024a) to Hispanic-serving institutions, several factors limit comparability. These include differences at the micro-level, such as curriculum revisions based on earlier findings, slight rewording of motivation items to capture situational nuance, and differing patterns of attrition and course participation. High attrition in later chapters may introduce bias and limit the generalizability of our findings. While this is a significant limitation, we used multiple imputation with auxiliary variables (e.g., expectancy, intrinsic and utility value, cost, and earlier review question scores) to reduce bias under the assumption that data are conditionally missing at random (MAR). We also conducted analyses to estimate results separately for students who completed all nine chapters (completers) and those who did not (non--completers), allowing us to assess the potential impact of MNAR patterns. These methods help buffer against the effects of missingness and increase confidence in the robustness of our findings, though some residual bias may remain if unobserved factors related to attrition were not fully accounted for. Additionally, macro-level contextual differences that limit comparability include institutional characteristics (e.g., selectivity, proportion of racially minoritized students), sample features (e.g., convenience sample vs. random sample, type of course), and

instructor-related factors (e.g., experience, approach to inclusion, growth vs. fixed mindset) further complicate direct replication across studies. Another limitation includes our measure of academic performance, which relied on embedded chapter review questions that may not fully capture summative academic achievement. These questions were primarily designed as formative checks for understanding, and grading practices likely vary widely across instructors - some may grade based on completion, others on correctness, and some may not grade or even assign them at all. To address this limitation, the first author, in collaboration with the curriculum developers, supported efforts to design a summative performance assessment that is currently under review. The goal is to embed this assessment directly into the textbook, accompanied by standardized grading guidance for instructors, to provide a more valid and consistent measure of students' cumulative learning. Future work will be able to use the more summative performance assessment as a more reliable and valid indicator of performance. Finally, we only captured one facet of cost (cost related to time and effort) and acknowledge that this item does not capture more internal dimensions of cost perception (e.g., emotional or psychological cost). An additional item ("The previous chapter was stressful for me") has since been added to the textbook to better represent these dimensions.

8. Conclusion

By extending our study to a different institutional context, specifically, Hispanic-serving institutions, this research contributes valuable insights into the generalizability of existing motivational theories and motivation-performance dynamics across diverse student populations and different institutional contexts. In doing so, it responds to growing calls in the field to investigate the situational nature of motivation (e.g., Lauermann, 2024; Pekrun & Marsh, 2022; Sutter et al., 2024a). Using an intensive longitudinal design, we found that all four motivational beliefs - expectancy, intrinsic and utility value, and cost - showed substantial within-student variability attributable to situational factors, a dimension often overlooked in traditional research that has traditionally emphasized between-student differences. Importantly, this within-student variability explained unique variance in students' statistics performance, though the strength and direction of associations differed from prior findings at predominantly White/Asian institutions. These results suggest that the predictive power of motivational beliefs may be underestimated when their dynamic, context-sensitive nature is not taken into account. Inconsistencies in patterns of association and demographic moderators highlight the importance of examining how cultural context shapes students' motivation and academic outcomes. Continued research across varied institutional settings is essential to advancing more equitable and contextually grounded motivational science.

CRediT authorship contribution statement

Claudia C. Sutter: Writing – review & editing, Writing – original draft, Supervision, Software, Resources, Project administration, Investigation, Data curation, Conceptualization. **Delaram A. Totonchi:** Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **Jamie DeCoster:** Writing – original draft, Visualization, Methodology, Investigation, Formal analysis. **Chris S. Hulleman:** Writing – review & editing, Conceptualization. **Kenneth E. Barron:** Writing – review & editing, Conceptualization.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.learninstruc.2025.102304.

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