

Bridging Theory and Measurement of Student Engagement: A Practical Approach

Barbara Means
Julie Neisler
Digital Promise, USA

Abstract

Learner engagement is well-established as critical for learning online. Professional development for online instructors emphasizes techniques for engaging students, and learning technology products tout features intended to promote engagement (e.g., adaptive content, video, gamification). But the influence of particular instructor practices and of particular learning technology features on theory-based aspects of student engagement is infrequently tested empirically, and even more rarely with Black, Latine, and low-income students, who are more likely to face barriers to learning online. This paper first provides a research-based theoretical model of affective engagement developed in conjunction with ongoing studies of blended learning implementations of courseware designed to enhance learning and engagement among historically and systemically marginalized students. Next, the paper describes development of survey-based measures of four components of affective engagement and the use of responses from over 850 students in introductory statistics courses to evaluate the reliability and factor structure of those measures. We conclude with implications for use of the engagement measures in future improvement-oriented research and practice.

Keywords: engagement, online learning, measurement

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In contrast to blended learning, for which there is ample evidence that the addition of learning technology elements enhances student engagement as well as learning (Means et al., 2013; Venn et al., 2020), online courses often have lower engagement levels and success rates, especially for students from low-income backgrounds and historically and systemically excluded race/ethnicity groups (Xu & Jagers, 2013, 2014). Nevertheless, the flexibility that online courses offer in terms of learning time and place is leading to increasing proportions of undergraduate students to select this modality (D'Agostino, 2022), adding urgency to efforts to enhance engagement to improve student retention and success.

When the COVID-19 pandemic forced a sudden shift to remote instruction, educators expressed concern about their ability to engage their students online (Walker & Koralesky, 2021). Students too perceived themselves to be less engaged (Walker & Koralesky, 2021). Indeed, a study of the perceptions of students who were in college courses with face-to-face meetings that had to shift online at the start of the pandemic found that students regarded maintaining their motivation to engage in the course as the biggest challenge to course completion (Means & Neisler, 2021).

While there is no shortage of exhortations to engage online students and tips on how to do so (Center for Innovation in Teaching and Learning, 2020; Dahl, 2015), evidence of the effectiveness of the recommended techniques for college students in particular course contexts is sparse (Venn et al., 2020). Instructors seeking an evidentiary basis for their pedagogy are faced with the difficult task of trying to draw inferences from the literature on theories of student engagement for their particular course context (Means, 2022). Their efforts are impeded further by a lack of accessible practical measures of course engagement that can be implemented within their own classes to measure the engagement experiences they are trying to enhance (Yeager et al., 2013).

The contemporary literature on postsecondary student engagement typically adopts the tripartite framework suggested by Fredericks, Blumenfeld, and Paris (2004), with affective/emotional, behavioral, and cognitive dimensions. Behavioral components of engagement are observable and hence can be captured by measures such as attendance, homework submission, and—with today's learning technology—the record of interactions with a digital learning system. Similarly, cognitive dimensions of engagement focused on deeper understanding are regularly evaluated in classrooms using formative assessments (e.g., clickers, comprehension checks). Measures of behavioral and cognitive engagement can tell an instructor when engagement is lacking, but not why it is lacking. Most college courses do not regularly measure affective/emotional engagement, and existing instruments for doing so have limitations (Mandernach, 2015).

Much of the academic literature on how to foster affective engagement of postsecondary learners online has been influenced by the Community of Inquiry (CoI) framework of Garrison, Anderson, and Archer (2000), which posits instructor, learner, and social “presences” as mechanisms for increasing engagement in online learning. A CoI survey, designed to measure students' perceptions of the strength of these three types of presence, has been used extensively. Kucuk and Richardson (2019), for example, report that students' perception of each type of

online presence is associated with self-reported engagement and course satisfaction. Course engagement and course satisfaction measures also were significantly correlated with each other.

Martin and Borup (2022) synthesized the literature on engagement in online and blended learning in a recent article for a special issue of *Educational Psychologist*. These authors posit that the essential dimensions of engagement are consistent across learning modalities, but their triggers and supports for engagement, and the behaviors through which they may be manifested, vary in online and in-person learning. For example, measures of behavioral engagement commonly used in studying online learning (e.g., number of modules attempted) differ from those used in face-to-face settings (e.g., attendance) in that some level of technology fluency is needed to engage online. It is also important to note that many online courses are designed to maximize flexibility of learning time as well as place. While this flexibility can lead to greater access for minoritized populations, it also leaves it up to students to pace their learning in a way that allows them to finish the course in time to earn course credit, hence increasing the level of behavioral engagement needed to succeed. Martin and Borup concluded that online learning requires higher levels of cognitive engagement and increased interaction with the instructor to be successful. Blended or hybrid courses that mix in-person and online modalities may help reduce the demand on learners' ability to regulate their own engagement, but from a research perspective introduce further complexity, since obstacles to and supports for engagement in the course's two modalities may interact (Halverson & Graham, 2019).

Outside the field of learning technology, scholars of motivation and engagement focus on psychological constructs and processes, such as expectation of success or sense of belonging (Greenhow, Graham, & Koehler, 2022). In contrast, the literature on engagement in online and blended learning typically defines engagement concretely in terms of what the learner interacts with (e.g., the instructor, course material, or other learners) or the mechanism for interacting (e.g., discussion board, videoconference) rather than internal psychological processes. For example, a meta-analysis by Bernard et al. (2009) examined learning and achievement outcomes for online learning interventions involving student-student, student-instructor, or student-content interactions and found that each of these led to increased learning. The authors interpreted their findings as indications that each kind of interaction increases cognitive engagement.

The Academic Communities of Engagement model developed by Borup and colleagues (Borup et al., 2020) lays out categories of supports for affective and behavioral engagement online, highlighting the importance of a student's personal community as well as their course community. This model suggests that when there are gaps between an online student's level of engagement when learning independently and that which is required for online course success, both their course community (classmates) and their personal community (e.g., friends or family) may help them close that gap.

In short, agreement about the importance of engagement for learning online is widespread, but understanding of the multiple aspects of engagement as they are manifested in online and blended course contexts and knowledge of specific practices that support affective engagement at the college level is more elusive. An easy-to-use approach to measuring affective engagement would enable instructors to collect data as feedback on the effectiveness of instructional practices intended to enhance student engagement.

Many existing student engagement measures have been developed to capture academic engagement in general (e.g., Appleton et al., 2006) or engagement with a student's higher education institution overall (e.g., Bowden et al., 2021; Kuh, 2001). While useful for some purposes, such measures do not inform an individual faculty member about the engagement patterns of students in their course or tell a department chair whether their gateway courses are promoting the kind of affective engagement that can lead to continued study in the department. The instrument development effort described here is part of a larger research effort being conducted with the goal of supporting postsecondary institutions seeking to leverage online learning to achieve better and more equitable outcomes for their gateway courses, leading us to develop measures of student engagement fitted to the context of an undergraduate course with a diverse student enrollment.

We conducted the work described here as part of a broader initiative to support Black, Latine, and low-income college students taking gateway college courses with the goal of enabling them to succeed at the same level as the highest-achieving demographic groups in those courses. Equity issues in gateway courses are of vital importance, given the relationship between performance in those courses and college retention and degree completion (Hughes & Pace, 2003). Although the sources of differences in gateway course success are numerous, many researchers suggest that they include differences in students' engagement with the course, which mediates learning and grade outcomes (Ketonen et al., 2005; Shernof et al., 2017). For our ongoing research on technologies and instructional practices that enhance Introductory Statistics learning and course outcomes, we needed a cost-effective tool for measuring the multiple dimensions of affective engagement that might mediate courseware impacts. This paper describes the development rationale and factor exploration for a set of course affective engagement scales. The resulting measures will be used in studies examining the influence of new learning software and of particular instructor practices on course engagement, statistics learning, and course outcomes for low-income, Black, and Latine students.

Conceptualizations of Engagement

The scholarly literature on motivation and engagement is vast, and there is no single generally accepted theoretical framing of key issues (Kinsella et al., 2022; Mandernach, 2015). Early treatments of learner motivation and engagement often treated these concepts as relatively stable characteristics of individual learners. Differences in learner behavior were ascribed to their having high or low achievement motivation, intrinsic or extrinsic motivation for learning, or performance or mastery goals. These concepts were used to try to explain differences in time on task, which predicts learning outcomes (Carroll, 1963).

Today, there is much broader appreciation for the importance of affective and sociocultural aspects of learning as part of a broader concept of engagement (Ladson-Billings, 2023; National Academies, 2018). There is also growing awareness of the pernicious effects of inequities baked into our educational institutions and our culture more broadly, with students of color, low-income students, and other marginalized groups subjected to low expectations, bias, and stereotype threat.

We will first review three frequently used instruments for measuring engagement in higher education, highlighting their gaps with respect to affective engagement, and then describe the theoretical basis for the engagement measures we developed and explored.

Existing Course Engagement Measures for Higher Education

The widely used *National Survey of Student Engagement* (NSSE) examines student participation in campus life and some of its scales have been shown to predict college persistence (Shinde, 2010). Because the items in *NSSE* ask students to describe their behaviors in general (with items such as “How much does your institution emphasize getting involved socially?”), the instrument is not suitable for use by an individual faculty member or course designer seeking to investigate relationships between particular curriculum features or instructional practices and student engagement. The *Classroom Survey of Student Engagement* (Ouimet & Smallwood, 2005) was developed as an outgrowth of the *NSSE* and elicits student reports of the frequency with which they engage in certain classroom activities (e.g., asked questions during class). While this measure could be used by a faculty member in regard to an individual course, it again homes in specifically on behavioral engagement.

Much less work has been done developing and using measures of the multiple aspects of engagement within a specific college course (Mandernach, 2015). The 27-item *Student Course Engagement Questionnaire*, which was developed with students taking psychology, political science, and mathematics classes at a single institution (Handelsman, Briggs, Sullivan, & Towler, 2005), does ask the respondent to think about a specific course, but the questionnaire items are domain-agnostic. To the extent that stereotype threat or pre-existing beliefs about a particular subject are important for understanding student motivation in a course, the instrument is less than ideal. In addition, *Student Course Engagement Questionnaire* items were generated by asking instructors what engaged students do in class (e.g., coming to class every day, applying course material to my life). As a result, the instrument also has a behavioral rather than an affective emphasis. Moreover, it can be seen as conveying the implicit message (to both students and instructors) that engagement is about actions and the responsibility of the student, rather than something that emerges in the interplay between the student, course content, and the way the course is structured and taught (Cohen, Raudenbush, & Ball, 2003).

Theoretical Basis for an Affective Engagement Measure

Affective engagement is a crucial dimension of Fredericks, Blumenfeld, and Paris’s (2004) tripartite approach, yet it is often assumed to be captured by behavioral and cognitive engagement measures or treated as an outcome rather than as an influence on learning (e.g., Cho, Park, & Lee, 2021; Kirby & Thomas, 2022; Martin & Bolliger, 2018). We seek to build on the extensive prior literature to identify and measure the key components associated with affective engagement.

The majority of our *Course Engagement Survey Items* focus on different aspects of affective engagement emphasized in contemporary theoretical work. In developing our items and examining whether they would form scales, we drew on situated expectancy value theory (Eccles & Wigfield, 2020; Wigfield & Eccles, 2000), interest and identity development research (Renninger & Hidi, 2011; 2022), and research on performance anxiety and stereotype threat (Steele, 1997). The situated expectancy value framework conceptualizes motivation for an

activity as a product of the subjective value of the task and expectations around success with the task if one engages in it. There are multiple kinds of task value (enjoyment, utility for achieving future goals, and attainment of something that is central to the learner's identity). On the negative side of the value ledger are perceived costs of engaging in the task. Costs can include not only time and effort but also opportunity costs (other activities that must be sacrificed) and potential emotional costs, such as fear of failure or of being perceived by one's peer group as doing something inappropriate.

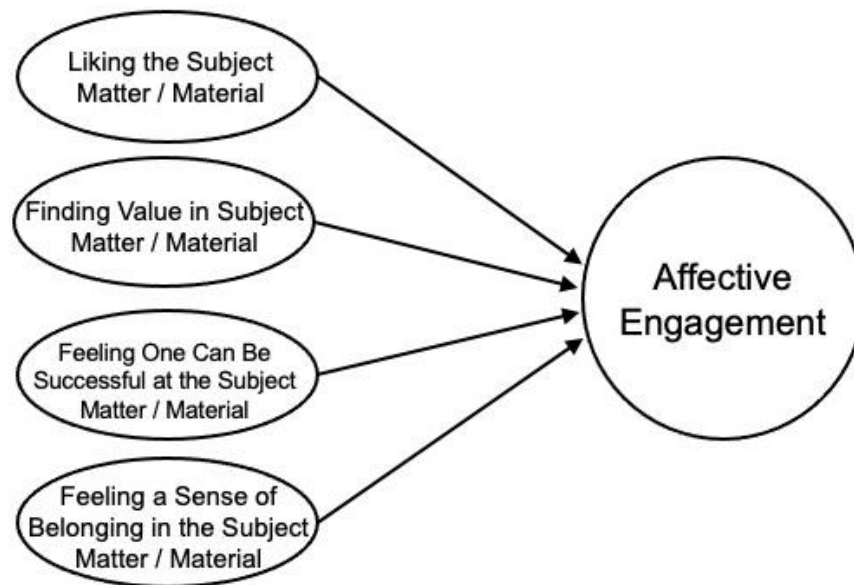
Renninger and Hidi (2022) provide a more developmental perspective in describing how what starts as situational interest in a task or subject (e.g., "this is a cool puzzle") can over time lead to sustained interest in a general activity category and seeking opportunities to engage in it (e.g., "This web site has math puzzles so I might like it."), resulting in ascribing increasing value to the task and even incorporating the interest into one's identity ("I'm a person who likes math puzzles"). The flip side of interest and identity development occurs when a person experiences frustration or boredom with certain activities and develops ideas about not being interested in them, often accompanied by avoiding those activities and sometimes a negative identity with respect to them ("I'm not a math person").

Sense of belonging has been conceptualized as a basic human need. Strayhorn (2018) describes it in the college context as perceived social support, a feeling of connectedness and being cared about, accepted, respected, valued by, and important to others on campus. While sense of belonging is important to everyone, students finding themselves in situations where few others share their identity characteristics are likely to be more vulnerable to feelings they do not belong (Walton & Cohen, 2011). Students are well aware of stereotypes about who does well in different academic content areas, and when engaging in an activity where individuals with their external characteristics are stigmatized and expected not to do well, they feel psychological threat and raised anxiety, which can consume so much of their working memory that they have less capacity available to focus on the task at hand (Schmader, Hall, & Croft, 2015). Stimuli that suggest that they don't belong (for example, consistent depictions of people successful in the subject domain as people who do not look like them) can aggravate stereotype threat and reduce students' sense of belonging in a course, program, or college generally (Walton & Cohen, 2014). Interventions inserted into a course to help students reframe difficulties adjusting to college and feelings of social isolation as normal and short-lived have been shown to raise Black students' grade-point average while not affecting that of White students (presumably because fewer of them suffered from feelings that they did not belong) in a series of experimental studies (Walton & Cohen, 2011; Walton & Wilson, 2018).

A number of researchers have suggested that the modality in which a course is taught can influence sense of belonging. Schaeffer and Konetes (2010), for example, suggest that social isolation is one cause of the higher attrition rate in online courses compared to face-to-face courses. Halverson and Graham (2019) describe widely held optimism around the promise of blended learning for promoting stronger student engagement than either purely online or purely classroom-based learning but note that a lack of measures of individual components of engagement and the conflating of engagement indicators and engagement-inducing practices in instruments like the NSSE impede efforts to develop a strong foundation of empirical research on the topic.

Drawing on the perspectives described above, we posited four components of affective engagement, as shown in Figure 1. These four components are liking the subject matter/material, finding value in the subject matter/material, feeling one can be successful at the subject matter/material, and feeling a sense of belonging in the subject matter/material. Prior studies suggest that many Black, Latine, and low-income students come to their first college courses with self-doubts and a lack of confidence about belonging stemming from past educational experiences and exacerbated by questions about whether college is for them (Meriwether, 2019; Steele, 1997). Though the literature supports the premise that there are differences in the prevalence of self-doubt among different subgroups of students, we do not assume that students can be dichotomized into uniform “privileged” and “non-privileged” groups, nor that all students within a particular demographic group will have the same experiences and motivational profile.

Figure 1
Theory-based Components of Affective Engagement



Our purpose in developing the *Course Engagement Survey Items* for Statistics was to make an instrument that would be useful in course improvement efforts and professional development by reflecting the interplay between student characteristics, instructional practices, and disciplinary content. This goal requires both attention to sociocultural and equity issues that impact many students and being specific about the subject domain of the course. There is a considerable body of research on learner attitudes toward different academic disciplines, particularly in STEM areas. Longitudinal studies have documented waning interest in science and mathematics over the secondary school years (Osborne, Simon, & Collins, 2003) as well as anxiety related to mathematics (Ramirez, Shaw, & Maloney, 2018). These affective responses are differentially prominent among young women and students of color (Meriwether, 2019; Shapiro & Williams, 2011), with implications for their expectations and sense of belonging in courses in these fields.

While previous efforts to develop course engagement survey scales have ignored course discipline, we intentionally modified selected items taken from prior instruments to ask respondents specifically about their affective engagement with statistics and mathematics content and activities. This strategy is consistent with prior methodological research showing that engagement self-report instruments work better when they are matched more specifically with the context in which they will be used (Fuller et al., 2018). Finally, we wanted to have engagement scales that would be usable in online courses with synchronous activities as well as in face-to-face and blended or hybrid courses.

Methods

Survey Instrument

We reviewed items in prior course engagement instruments, specifically, the widely used *Motivated Strategies for Learning Questionnaire* (Pintrich et al., 1991) and the sense of belonging items used by Ingram (2012) with the goal of identifying three to five items for each of the components of affective engagement shown in Figure 1. A team of four researchers adapted items from the Pintrich et al. and Ingram instruments to refer specifically to a statistics course, taking care to keep items concise and easy to read. The team generated new items in cases where aspects of engagement noted in the research literature were not covered by the desired number of items. A series of successive reviews by the team identified items that appeared to capture the relevant component parsimoniously. Items were grouped and ordered to provide a logical flow for the student respondent, and a small set of response options (e.g., *Strongly Disagree, Disagree, Agree, Strongly Agree*) was used to reduce the cognitive burden that frequent switching of response scales would impose. Table 1 shows the items we used for the four theory-based components of affective engagement. Items that are reverse coded are noted as such, and with an [R] in later tables.

Table 1
Course Affective Engagement Scale Items for Statistics

Component	Item
Liking	I am finding this course very enjoyable. I think statistics is interesting.
Value	Getting course credit is the only value I see in taking this course. [REVERSE] Statistics skills will make me more employable. I think I will be able to use what I'm learning in this course in other courses. I think statistics is worthless. [REVERSE] I can use statistics in my everyday life.
Success Expectation	I understand statistics well enough to use it in my everyday life. When I work on statistics problem sets, I get most of the answers right. Taking this course has helped me to understand statistics better. I feel confident that I am mastering the content of introductory statistics. I have trouble understanding statistics. [REVERSE] I feel insecure when I have to do statistics problems involving many calculations. [REVERSE]
Sense of Belonging	I feel respected by the instructor of this course. I feel like other students in this course understand my ideas when I share what I am thinking.

I feel like the instructor in this course encourages me to do well.
I feel respected by other students in this course.
I can be myself with other students in this course.
If I face academic challenges in this course, I feel comfortable asking the instructor for help.

Introductory statistics course instructors invited students to participate in the survey about two-thirds of the way into the semester, with several incorporating the student survey into their course syllabus. Students consented prior to beginning the survey, following procedures approved by Salus IRB (and also campus review boards where required). All participating instructors offered students a modest amount of extra credit for completing the online survey, which was delivered via Qualtrics. Student responses were anonymous; after completing the survey students clicked a provided link to go to a separate location to provide their name for the list of students earning extra credit (precluding both the research team and the instructor from connecting an individual student to their survey responses).

Sample

A total of 17 statistics instructors from 11 institutions (five two-year colleges and six four-year colleges and universities) participated in the study. The research team prioritized recruiting of instructors from broad-access institutions; all but 1 of the 11 participating institutions accepts over 70% of the students who apply; 6 of the institutions use open enrollment. The institutions were located in six different states (New York, California, Ohio, Arizona, Florida, and Kentucky). Six of the 11 institutions had a Minority-Serving Institution (MSI) designation, including 3 Hispanic-Serving Institutions (HSIs), 1 Asian American and Native American Pacific Islander Serving Institution (AANAPISI), 1 Native American Serving Non-Tribal Institution (NASNTI), and 1 with both an HSI and an AANAPISI designation. The proportion of their students who were Pell grant recipients ranged between 17% and 47% for the 11 institutions; the proportion of their students identified as Racially-Minoritized ranged from 17% to 68%.

At the beginning of their semesters, 1,351 students were enrolled in the introductory statistics courses taught by participating instructors; the sum of instructors' estimated student course enrollments at the time they distributed the survey was 1,207. A total of 1,145 students (non-unique) in the 17 courses consented to participate in the research. A student's survey responses were excluded from the analysis if: the first item of the survey was not completed ($n = 67$), Qualtrics flagged the response as a duplicate ($n = 123$), or Qualtrics flagged the response as a fraudulent/bot response ($n = 26$). The final analytic sample represents 928 unique student responses, an unweighted response rate of 77% of the estimated course enrollment. Response rates varied by instructor, ranging from 33% to 100%, with a weighted response rate of 69%.

For factor analysis, responses with incomplete data on the 19 engagement items were also removed, resulting in an additional exclusion of 60 responses. To determine if the removal of these responses influenced the sample composition, a missing data analysis explored the differences between respondents retained and respondents excluded. These groups were not significantly different on variables of race, gender, age, credit hours taken during the term, diagnosed with a disability or impairment, or whether the individual was working. Cell sizes

were not large enough to reliably assess differences based on whether students provided unpaid care during the semester. This suggests that the final retained analytic sample does not significantly differ by student identities and leads to a final analytic sample of N = 868.

Among the student survey sample, 60% self-identified as women and 76% as being of traditional college age (between 18 and 22 years old). Most students (77%) reported not being primarily responsible for providing unpaid care for someone other than themselves; just over half of the student sample (56%) reported performing some work for pay. Only 9% of the student respondents self-identified as having been diagnosed with a disability or impairment.

Students were provided the opportunity to select all that apply among Census race/ethnicity categories: Asian; Black or African American; Hispanic/Latine; Indigenous, Alaska Native, or American Indian; Native Hawaiian or other Pacific Islander; White/European/Caucasian, with an additional blank text box for entering Another Race Not Listed. While there was a total of 33 unique response combinations, most students (85%) identified a single race/ethnicity for themselves with 4% declining to answer the question and 11% selecting multiple options. Response counts and proportions can be found in Table 2. As can be seen in the table, 35.5% of survey respondents included White/European/Caucasian among the race/ethnicity categories they identify with, but only 28.2% of respondents selected White/European/Caucasian as the only race/ethnicity category they identify with.

Table 2
Self-identified Race/Ethnicity Responses of Survey Respondents

Race/Ethnicity	% [N] Duplicated Count*	% [N] Unduplicated Count
Asian	30.4% [264]	26.2% [227]
Black or African American	10.6% [92]	7.4% [64]
Hispanic/Latine	25.1% [218]	21.0% [182]
Indigenous, Alaska Native, or American Indian	2.4% [21]	0% [0]
Native Hawaiian or Other Pacific Islander	1.3% [11]	0.2% [2]
White/European/Caucasian	35.5% [308]	28.2% [249]
Another Race Not Listed	2.5% [22]	1.8% [16]
Multi-Racial		10.8% [94]

* Duplicated count percentages add to more than 100% because students could select all that apply.

Results

Exploration of Inter-Component Relationships

The first set of analyses explored the relationships of items within each component. The two Liking component items are strongly correlated with each other ($r = 0.62$), but more items would be needed to investigate the factor structure, the ultimate goal of this analysis.

Analyses of the Value component suggested that the reverse-coded survey items do not correlate well with other items in the Value measure. The inter-item correlations in Table 3

highlight the relatively weak relationship between reverse-coded items and the other Value items ($r < 0.36$). However, the remaining items show correlations that are acceptably high ($r > 0.50$) but not so high as to suggest multicollinearity.

Table 3
Correlations Among Survey Items Addressing Statistics Value

	1 [R]	2	3	4 [R]	5
1. Getting course credit is the only value I see in taking this course. [R]	-				
2. Statistics skills will make me more employable.	0.33	-			
3. I think I will be able to use what I'm learning in this course in other courses.	0.34	0.62	-		
4. I think statistics is worthless. [R]	0.51	0.35	0.35	-	
5. I can use statistics in my everyday life.	0.30	0.53	0.61	0.34	-

Similarly, for the Success Expectations items, correlations between reverse-coded items and positively coded items are weaker ($0.20 \leq r \leq 0.46$) than those among positively coded items ($0.47 \leq r \leq 0.64$). All the positively coded items have acceptable levels of correlation for retention in the component, as shown in Table 4.

Table 4
Correlations Among Survey Items Addressing Statistics Success Expectations

	1	2	3	4	5 [R]	6 [R]
1. I understand statistics well enough to use it in my everyday life.	-					
2. When I work on statistics problem sets, I get most of the answers right.	0.54	-				
3. Taking this course has helped me to understand statistics better.	0.48	0.47	-			
4. I feel confident that I am mastering the content of introductory statistics.	0.63	0.64	0.58	-		
5. I have trouble understanding statistics. [R]	0.46	0.42	0.30	0.45	-	
6. I feel insecure when I have to do statistics problems involving many calculations. [R]	0.29	0.34	0.20	0.35	0.60	-

Finally, an unanticipated pattern emerged among the Sense of Belonging items, as shown in Table 5. Items dealing with the relationship with the instructor demonstrate strong relationships to each other ($0.74 \leq r \leq 0.81$), and items concerning belonging and acceptance among peers are highly correlated with each other ($0.53 \leq r \leq 0.61$). Sense of Belonging items referring to

instructors and those referring to peers are only modestly associated with each other, however ($0.26 \leq r \leq 0.38$). This finding suggests that the belonging-related items reflect two distinct components—Sense of Belonging as facilitated by instructors and Sense of Belonging as facilitated by peers.

Table 5
Correlations Among Survey Items Addressing Sense of Belonging

	1	2	3	4	5	6
1. I feel respected by the instructor of this course.	-					
2. I feel like the instructor in this course encourages me to do well.	0.81	-				
3. If I face academic challenges in this course, I feel comfortable asking the instructor for help.	0.78	0.74	-			
4. I feel like other students in this course understand my ideas when I share what I am thinking.	0.31	0.29	0.35	-		
5. I feel respected by other students in this course.	0.36	0.33	0.34	0.53	-	
6. I can be myself with other students in this course.	0.31	0.26	0.38	0.60	0.61	-

To ensure that there is sufficient internal similarity for items remaining after deleting those with reverse coding, we computed Cronbach’s alpha for each engagement component and then for all Affective Engagement items together. The alpha values, shown in Table 6, suggest an acceptable level of inter-relatedness for each of the components without redundancies. The alpha for the entire set of Affective Engagement items, at 0.811, shows good reliability.

Table 6
Reliability of Affective Engagement Component Measures

Component	Number of Items	Cronbach’s Alpha	Cronbach’s Alpha
Value	3	0.787	0.811
Success Expectations	4	0.726	
Sense of Belonging—Instructor	3	0.910	
Sense of Belonging—Students	3	0.804	

Factor Analysis

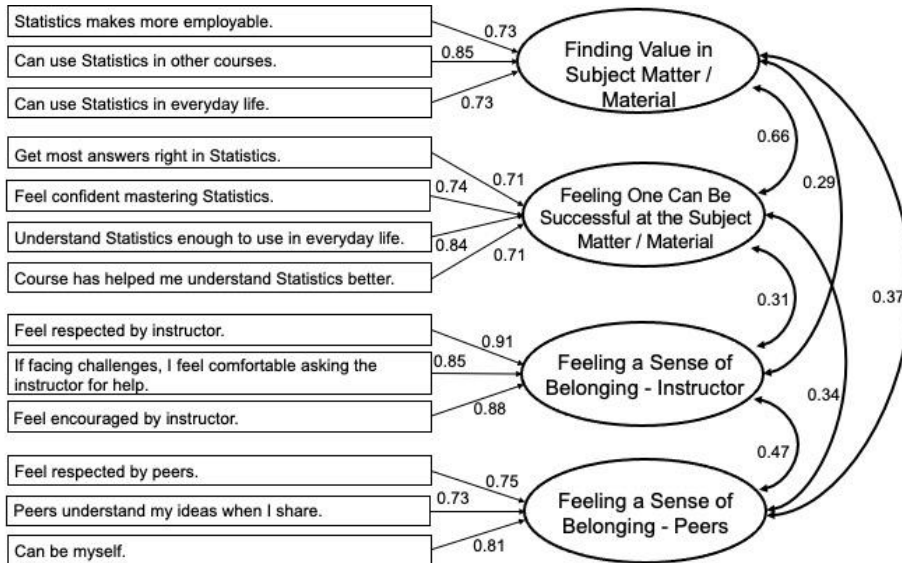
As described above, four potential components of affective engagement emerged from the initial item exploration (Value, Success Expectations, Sense of Belonging—Instructor, and Sense of Belonging—Peers). Given the strong a priori theory underlying the instrument, a confirmatory factory analysis (CFA) was used to test how well the observed data fit the underlying theoretical structure (McCoach, Gable, & Madura, 2013). The CFA was conducted using R version 4.2.2 (2022-10-31) (R Core Team, 2021) and the *lavaan* package version 0.6-16 (Rosseel, 2012). An overall latent model for affective engagement was not explored due to Liking items missing from the theoretical model, though all four components were allowed to

covary to investigate the relationship between them and an initial factor structure without Liking. The model was estimated using the Maximum Likelihood estimator. To assess model fit, three indices were used: absolute fit as represented by Standardized Root Mean Square Residual (SRMR), parsimonious fit as represented by Root Mean Square Error of Approximation (RMSEA), and relative fit as represented by Comparative Fit Index (CFI).

Model Results

The final model, shown in Figure 2, is based on a confirmatory factor analysis of 13 items representing four theoretical components of affective engagement. Model fit indices are as follows: SRMR = 0.034, RMSEA = 0.053, and CFI = 0.978. According to Hu and Bentler (1999), model-data fit can be considered good if the SRMR value is $\leq .08$, the RMSEA value is $< .06$, and the CFI value is $> .95$. Based on these criteria, the data fit the model well. Additionally, the standardized factor loadings for all 13 items exceed 0.70, suggesting a sufficient relationship between each item and the represented latent construct (Hair et al., 2006; Stevens, 1992). The magnitude of the relationship between components varies by construct. Value and Success Expectations are strongly correlated ($r = 0.66$), and the two Senses of Belonging have a lower, but still noteworthy, relationship to each other ($r = 0.47$). The remaining relationships between constructs demonstrate moderate relationships ($.29 \leq r \leq 0.37$).

Figure 2
Final Model for Affective Engagement in Statistics Courses



Modelling for Students of Color

To support our larger research goal of understanding affective engagement among racially-minoritized students, we next explored the factor structure using data from just those students. For this analysis, we removed the survey data for the 28.2% of the survey takers who identified as White/European/Caucasian only. The remaining data subset contains responses from 585 students who selected at least one racially-minoritized identity.

The model results for racially-minoritized students similarly demonstrates good model fit with the following model fit indices: SRMR = 0.040 (below the recommended 0.08), RMSEA = 0.058 (below the recommended 0.06), and CFI = 0.973 (above the recommended 0.95). Additionally, all standardized factor loadings remained above 0.70 (ranging from 0.72 to 0.87). Relationships among factors are comparable to those seen using the entire student sample, with Value and Success Expectations strongly correlated at $r = 0.68$, and the two Senses of Belonging correlated at $r = 0.50$. The remaining relationships between constructs continued to demonstrate moderate relationships ($0.31 \leq r \leq 0.38$).

Limitations

The student sample used to test the quality of the survey items was large enough to support examination of item characteristics among the non-White portion of the sample, as reported above, but not large enough for exploration of the factor structure for individual race/ethnicity groups. Future work should explore the factor structure for particular race/ethnicity groups and ideally, for groups defined by the intersection of race/ethnicity and gender categories. In addition, it should be remembered that the survey data reported here were collected at a single point in time, precluding testing of hypotheses about causal relationships among particular components of student course engagement (e.g., whether increases in success expectation lead to increased sense of belonging). Finally, the survey used in this research included only two items addressing student liking and interest in statistics. These two items were sufficient to provide a fairly reliable measure ($r = 0.62$) but were insufficient to support inclusion of the Liking component in the factor analysis. More liking/interest items are needed to build a factor that can be tested as part of affective engagement.

Discussion

Advantages Over Prior Measures of Course Engagement

The *Course Engagement Survey Items* address the two key weaknesses of prior measures noted by Halverson and Graham (2019): These survey items provide individual measures of conceptually distinct components of affective engagement, and they deal exclusively with engagement indicators rather than mixing indicators with engagement *practices* (such as participating in small group projects). A third advantage is that these item scales can be tailored to apply to a specific course. Prior research on student engagement interventions has found that they are most effective when they invoke a specific context within a particular course (Hulleman & Harackiewicz, 2020), making engagement items that inquire about college experiences in general less than optimal as outcome measures for course improvement efforts. The *Course Engagement Survey Items* are compatible with course-level interventions because they address a specific course and subject area (in this case, statistics). At the same time, the domain-specific items on the *Course Engagement Survey Items* could be easily adapted for use in courses in different subject areas (in fact, we are currently adapting them for use in chemistry classes). Whatever the academic discipline, the scale items prompt students to think about a specific course in a specific subject area, not their college experiences overall.

A final advantage of the *Course Engagement Survey Items* is that they are usable in courses taught in any modality. In contrast to previous course engagement instruments, we avoided using items pre-supposing in-class meetings, such as “Raising my hand in class,”

“Taking good notes in class” (Handelsman et al., 2005) or “I go to class every day unless I am sick” (Lin & Huang, 2018). An affective engagement instrument that can be used in classes taught in any modality has the advantage of enabling an instructor to gauge whether a shift in course modality is influencing the level of student engagement. Further, if combined with information on student characteristics, a department could use aggregated data from such an instrument to investigate whether a change in course modality has differential consequences on affective engagement for different kinds of students.

Prior research suggests that this may indeed be the case, but that multiple factors of both identity and life circumstances need to be considered. During the first semester of the COVID-19 pandemic, for example, students from historically and systematically excluded race/ethnicity groups reported more barriers to full engagement in online course meetings than White and Asian students did (Means & Neisler, 2020). Nevertheless, the majority of these students (60%) reported that the extent to which they felt included as a member of their class was as good or better when the class shifted online compared to when the class included in-person meetings. In contrast, among White and Asian students, only 39% reported their sense of belonging as staying as strong or stronger when their course shifted to learning online. It is possible that this difference in modality effects on sense of belonging occurs because students from nondominant groups experience more negative affect related to microaggressions or stereotype threat when participating in face-to-face classes (Ogunyemi et al., 2020) than they do when learning online.

Consistency with Contemporary Theory on Affective Engagement

The four theory-based scales emerging from our survey item development and factor exploration are consistent with contemporary approaches to affective engagement in suggesting that it is not a unitary construct. The groups of items selected for measuring Value, Success Expectation, and two forms of Belonging all form highly reliable scales while being distinct from each other. Consistent with theorizing provided by Renninger and Hidi (2020), Valuing and Success Expectation were highly related ($r = .70$) in our survey sample. Neither of these measures was strongly correlated with either of the Sense of Belonging measures, suggesting that the community aspect of a course operates somewhat independently from appreciation of the subject matter or confidence in being able to master it. Our factor analysis also suggests that Sense of Belonging *vis a vis* other student needs to be considered separately from Sense of Belonging *vis a vis* the course instructor. There is a moderate correlation between the two feelings ($r = .47$), but they are distinct enough to suggest treating them as separate course outcomes.

Methodological Insight

An unexpected methodological finding was the fact that reverse-coded items did not correlate as strongly as other items did. These items were included to provide a check on respondents' acquiescence bias, with the intention of slowing the respondent down and fostering careful consideration of each survey item. It is possible, however, that students have difficulty shifting between thinking about the presence of positive aspects of their course and thinking about negative aspects of it. Several empirical studies have found that the inclusion of reverse-coded items in Likert-type survey scales reduces scale reliability and may be especially problematic for respondents with language difficulties (Suárez-Álvarez et al., 2018). The diverse racial/ethnic backgrounds of our student sample make it highly likely that some respondents'

first language was not English and switching from “Agree” to “Disagree” to indicate a positive evaluation of their course may have imposed additional cognitive burden for them.

Utility for Improving Engagement in Online and Blended Courses

The fact that the four affective engagement factors can be assessed efficiently through a brief 13-item survey makes it practical for use in course improvement and professional development initiatives. The scales meet the criteria Yeager et al. (2013) set forth for “practical measurement” for purposes of improvement. An instructor who is introducing a new practice to enhance students’ confidence in their ability to master statistics, for example, could administer the relevant survey items before and after the practice is introduced to evaluate whether the goal has been achieved. Similarly, a professional development program designed to help faculty be more “present” for their online students, might choose to give students the opportunity to respond anonymously to the Sense of Belonging-Instructor items.

Faculty development activities and resources have increasingly dealt with “equity-minded” or “culturally sustaining” teaching practices (Hammond, 2014). These practices are based on the assumption that instructor actions, such as expressing confidence that every student can master the material or explicitly acknowledging diverse student identities, will have positive impacts on the sense of belonging experienced by students who have been historically and systemically underserved. Many of these practices are not straightforward to implement, however, and their impact is likely to depend on the skill and nuance with which they are executed. For example, Hulleman and colleagues have explored the impacts of interventions designed to help students connect course content to their own lives and found that instructor communication of the utility value of content can have unintended negative consequences for some students, leading these researchers to recommend ask students to make connections between course content and their values themselves (Hulleman & Harackiewicz, 2020). An easy-to-administer measure of key components of students’ affective engagement can make it possible for instructors to get feedback on the success of their equity-focused changes in practice as they implement and refine them over the course of multiple semesters.

It is important to note also that the responses of our diverse student sample suggest that fostering a sense of belonging is not entirely a responsibility of the instructor. Students also have perceptions of the extent to which their course peers respect them and accept them as they are. Lave and Packer’s (2008) conception of communities of practice as the fundamental context within which meaningful learning emerges would suggest that full-fledged participation in and identification with a community of peer learners is very important. The faculty role in promoting Sense of Belonging-Peers is not well understood, however. We would conjecture that the use of collaborative active learning with students working in small groups as a significant part of the course could promote Sense of Belonging-Peers, but the way in which the instructor organizes student-to-student interactions, course grading policies, and the particular mix of different kinds of students in the groups could all affect the impact of implementing peer learning. Given the advantages of collaborative active learning techniques for promoting cognitive engagement and learning (Chi & Wylie, 2014), measuring the impact of this teaching approach on Sense of Belonging-Peers in different online and blended learning contexts is an area ripe for future research.

Currently, we are using the affective engagement items in Table 4 along with an expanded set of Liking items in research with 26 introductory statistics instructors who are implementing learning courseware designed to give students carefully structured and scaffolded opportunities to learn and apply statistics concepts and methods. The courseware was specifically designed to foster both engagement and learning for students from groups historically excluded from statistics (Blacks, Latine, and Indigenous) and those from low-income backgrounds. In addition to promoting sustained effort and learning, we believe that affective engagement is important for its own sake: Students should not be bored or anxious in their college courses. At the same time, we conjecture that affective engagement in their statistics course will predict student success in terms of learning and course grades. Our current research, employing the *Course Engagement Survey Items* in the context of a blended learning innovation, will permit us to test this hypothesis empirically.

Declarations

The authors declare no conflicts of interest.

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