Abstract

This study examined the effects of an intervention that engages student voice in classroom assessment on student perceptions of power, motivation, and attitudes towards assessment in a STEM context. The intervention and survey followed first-year students enrolled in a year-long STEM course (n=240). Half of all sections were randomly assigned to the intervention; here, TAs solicited student voice in participation grading criteria. Linear mixed models were used to analyze effects of the intervention. While the intervention did not result in main effects for outcomes of interest, longitudinal changes in perceptions of power, motivation orientation, and grades were found for all students from Fall to Spring. The intervention did, however, have promising impact on motivation and power for first-generation students and those whose TA changed from Fall to Winter, respectively. Implications for students in STEM, particularly those from marginalized backgrounds, and future directions for research and practice are also discussed.

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Effects of Student Voice Intervention in STEM Classroom Assessment on Psychosocial Outcomes

Classroom assessment has been thrust into the pedagogical spotlight with the shifting of classroom dynamics—both physical and implicit—as a result of the "twin pandemics" (Bailey et al., 2022). The global COVID-19 pandemic in conjunction with the call for racial justice in the United States have highlighted the need for more equitable and anti-racist classroom practice (Cook-Sather, 2021; Kinzie, 2020). The student voice has historically been side-lined in our "testing legacy" demonstrating the disproportionate power dynamics of classroom assessment practice (Black & Wiliam, 2010). This asymmetry of power in assessment practice has adverse implications for student autonomy development, motivation, and academic achievement.

Theoretical Framework

New measurement theory is used here as a lens through which assessment is conceptualized (Bonner, 2013). While more traditional assessment and measurement theories (Traub, 1997; van der Linden & Hambleton, 2013) tend to focus on assessment practice in a silo of its inherent qualities, the new measurement theory grounds assessment practice in the interpretations of assessment score meaning by stakeholders (including students). This social-constructivist view—now the more common assessment perspective—suggests that assessment, judgements made in its regard and subsequent uses, are centered in context rather than having a predetermined and fixed meaning. The acknowledgment and grounding of assessment theory in social context is appropriate given the effect of

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the "twin pandemics," and inevitably gives rise to concerns of equity—including power - and which voices are included in the meaning-making of assessment use. In this way, the new measurement theory illuminates the periphery of assessment practice, which, from a critical perspective, must be acknowledged towards understanding and acting upon existing normative practice (Saulnier et al., 2008; Simmons & Page, 2010).

Motivation

Student motivation is a crucial factor in the type and extent of action taken by students in a classroom (Dweck, 1986), including their academic achievement (Graham & Weiner, 1996; Linnenbrink &; Pintrich, 2002). Goal-orientation, defined as approach versus avoidance of an outcome and mastery of a task versus performance on a task, is one way in which motivation relative to assessment practice can be conceptualized in the classroom (Elliot, 1999). Mastery- and performance-approach orientations have been associated with more intrinsic student motivation, while avoidance has been cited as a detrimental factor for intrinsic motivation (Elliot, 1994). Given literature that boasts the effects of autonomy development on student intrinsic motivation (Chirkov, 2009; Cho et al., 2022), one-sided assessment practices, particularly in STEM, may intuitively lead to poorer motivational and academic outcomes. Thus, the study of student involvement (or lack thereof) in assessment practice should consider issues of student autonomy and motivational development and how these may ultimately affect student outcomes.

Classroom Participation & Assessment

There have been calls in recent years for classroom assessment to address issues of equity that lead to graduation and retention disparity in higher education (Dorimé-Williams et al, 2022). Classroom participation has been demonstrated as a strong predictor of academic achievement for undergraduate students (Akpur, 2021), and is thus becoming a strongly suggested practice in STEM fields where achievement gaps are most disproportionate (Theobald et al., 2020). Research has demonstrated, however, that traditional classroom participation (i.e., "talking out") is not only theoretically inequitable (DiAngelo & Sensov, 2018) but has continued to prioritize those from over-represented racial-ethnic and gender groups (Reinholz & Wilhelm, 2022a). In one example of twenty undergraduate math classes over the course of three years, researchers collected video classroom observations and coded for both quantitative and qualitative participation from students (Reinholz et al., 2022b). Overwhelmingly, male students were significantly over-represented in traditional participation which was linked to increased performances in this population compared to their female counterparts. Such research highlights a potential domino effect wherein under-represented populations see poorer outcomes relative to classroom participation that prioritizes "patriarchal status quo" (Reinholz et al., 2022b, p. 220) within larger STEM contexts suffering from the effects of structural racism (Hatfield et al., 2022).

The current study builds on a pilot intervention of student voice intervention in classroom participation assessment on students' perceptions of power, motivation, and attitudes towards assessment in their STEM course with a large class of first-year STEM students over the course of their first academic year.

There are, however, changes that have been thrust onto the perception and practice of traditional classroom participation as a result of the twin pandemics. One such example is the use of synchronous instruction strategies that expanded the opportunities for online classroom participation (such as breakout rooms, polling and chat functions, etc.). Such innovation has not only been suggested as a potential avenue through which participation disparity may diminish, but has also called for an understanding of how such practice may impact perceptions of power in the classroom (Pusey et al., 2021). While modest attempts have been made to understand how student voice may benefit STEM classroom assessment relative to participation (Chase, 2020), such an intervention has not examined effects in larger samples or longitudinally.

Thus, the current study builds on a pilot intervention of student voice intervention in classroom participation assessment on students' perceptions of power, motivation, and attitudes towards assessment in their STEM course with a large class (n=240) of first-year STEM students over the course of their first academic year.

Methods & Materials

Participants in this study were undergraduate first-year students who enrolled in a STEM cluster course at a large U.S. public university in Fall 2020. The cluster program began as an initiative to aid in the college transition by creating "learning communities" focused within certain disciplinary topics where students take a series of courses for three consecutive quarters (one academic year). For this particular cluster the grading scheme did not involve a grading curve. Moreover, the course did not serve the purpose of "weeding" students out, but rather fostering student interest in STEM fields.

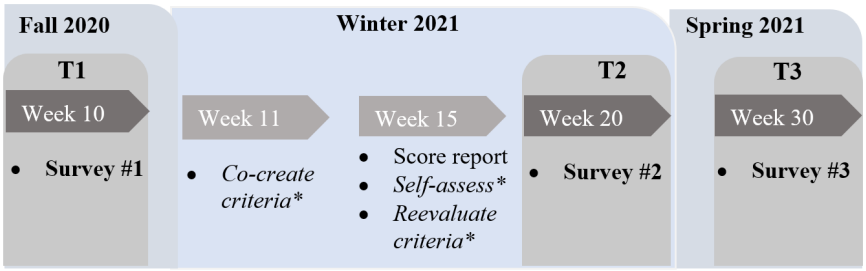
Participants in this study were undergraduate first-year students who enrolled in a STEM cluster course at a large U.S. public university in Fall 2020….The current study utilized an experimental, cluster randomization design to compare the effects of the intervention on students' perceptions of power, motivation, and attitudes towards assessment.

In total, 240 first-year students were enrolled in the STEM cluster beginning in Fall (T1), with some attrition during Winter (T2; n=238) and Spring Quarter (T3; n=232). Approximately 60% of participants self-identified as female and 40% as male. A third of participants identified ethnically as White, followed by 27% East/Southeast Asian, 14% South Asian, 16% Multiethnic, and 11% Latinx or Black/African American.

As the course took place during the COVID-19 global pandemic, it was adapted for online instruction. In T1 and T2, students had access to pre-recorded lectures, alongside attending weekly synchronous Zoom discussion sections (with approximately 20 students per section). Participation in the discussion section comprised 10% of a students' total grade in the course. The weekly lecture was taught by the instructor of record, while the discussion sections were facilitated by graduate TAs. It is within each individual discussion section that the intervention was implemented.

The current study utilized an experimental, cluster randomization design to compare the effects of the intervention on perceptions of power, motivation, and attitudes towards assessment both between and within-groups (Figure 1). IRB ethics approval was obtained prior to any study action and an informed consent waiver was distributed to all students outlining their participation in the intervention in T1. Half of all discussion sections (n=6) were then randomly selected to implement the intervention for the duration of T2, with the other half serving as control conditions. TAs whose sections were randomly assigned to receive treatment attended a workshop where the intervention protocol was presented and standardized such that all students experienced the same treatment. TAs whose sections were not randomly selected to participate in the intervention were not made aware of the intervention during this time and were simply told to conduct their sections as they normally would.

Figure 1
Graphic Timeline of Intervention



During the workshop, the researcher carried out the intervention as though the TAs were students in the class. Then, TAs practiced creating grading progressions (akin to rubrics) based on sample student criteria in order to calibrate a consistent standard for applying criteria to grades. All materials required for the intervention (including a personalized script of intervention preface, Mentimeter poll, Google Docs [Google, 2021], etc.) were provided for each individual TA via a secured Google Drive shared only between the researcher and TA. This ensured materials were the same across the intervention, as well as allowed for "process data" in order to ensure the intervention was carried out as intended. An email thread was used between the researcher, intervention TAs, and instructor in order to maintain uniformity across sections and answer any questions that arose about the process. Because the format of

the course shifted from lecture *and* discussion (in T1 and T2) to *solely* discussion sections in T3, the intervention only took place during T2. Business as usual resumed for the T3.

The overall aim of this intervention was to involve student voice in classroom assessment practice.

The first survey was administered at the end of T1 as a baseline of students' perceptions of power, motivation, and attitudes towards assessment, as well as key demographic information (see Appendix A for full survey). This allowed time for students to acclimate and gauge the classroom climate. Following the survey at T1, a second survey was administered at the end of T2 in attempts to gauge any changes in these perceptions over time/as a result of the intervention. A final survey was administered at the end of T3 in order to understand any lasting effects of the intervention from T2.

The Intervention

The overall aim of this intervention—as outlined in detail below—was to involve student voice in classroom assessment practice. More specifically, the intervention achieved the following: Firstly, it meaningfully engaged student voice in the assessment development process through the creation of participation evaluation criteria. Secondly, it allowed students an opportunity to stray from historical "dependence" (McCroskey & Richmond, 1983) on instructors for assessment evaluation, by allowing for self-assessment using the developed criteria. Additionally, as a result of having to create the criteria in addition to applying it via self-assessment, a final purpose of the intervention was to provide students a *holistic* experience—from the very beginning of determination of purpose to the "end result" of grading itself—of assessment in the classroom (generally solely experienced by instructors).

To further contextualize this intervention, the duration of this study took place during, arguably, the most turbulent period of the COVID-19 pandemic. This was a time in which instructors could no longer ignore student challenges that had heretofore remained 'outside' the classroom. While the switch to online instruction did expand the possibilities for classroom participation (i.e., written chat functions), it also presented potential barriers for participation for many students (i.e, access to electronic devices). Soliciting student voice in the assessment of participation helped illuminate potential inequities (i.e., access to reliable internet) as characterized by student criteria that allowed for participation that transcended traditional forms of participation (i.e., making notes on the collective class reading outside of class time). Thus, an added benefit of the intervention was the ability to cater to various needs during this time. For details on the intervention process itself, please reference [Chase, 2020]. Process data samples are provided in Appendices B, C, & D.

Operational Definitions & Measures

Power. Power was operationalized as students' perceptions of autonomy support from their instructor in addition to their perception of having a voice in the classroom. The 6-item "Learning Climate Questionnaire" (Williams & Deci, 1996) was adapted for the purpose of this study and was administered at T1-T3. Participants were prompted to "think about the way you are assessed by your TA and respond to the following prompts in regards to that assessment experience." Item responses were aggregated into a single perception of power score for each participant (a=.88).

Motivation. Motivation was operationalized as approach/avoidance and mastery/performance orientation relative to this course. The "Achievement Goal Questionnaire-Revised" (AGQ-R) probing intersections of approach/avoidance and mastery/performance goals, often used with undergraduate populations, was administered at T1-T3 (Elliot & Murayama, 2008). Only mastery approach (a=.84), performance avoidance (a=.85), and performance approach (a=.81) dimensions were of interest. As per validation findings for this measure as well as lack of operational clarity in the literature (Elliot et al., 2011; Madjar et al., 2011), the mastery avoidance orientation was not included in analyses as it is not a significant predictor of intrinsic motivation nor actual performance.

Attitudes toward Assessment. Student attitudes toward assessment was operationalized as students' preference and beliefs regarding assessment in their classroom. A 5-item version adapted from the "Attitudes towards Grading System" scale developed

by Pacharn et al. (2013) was used to gauge student attitudes. Item responses were then aggregated into a single attitude towards assessment score for each participant.

Academic Achievement. Final course grade percentages (which includes all course assessments from both lecture and discussion) served as a measure of students' academic achievement in this STEM course collected at each time point T1-T3.

Interest in STEM. Three items probed student interest in STEM majors given their experience in the course collected T1-T3. These included asking about students' comfort level with and belief about being successful in STEM, while the remaining items asked about student inclination towards pursuing a STEM major (a=.77).

Covariates. In addition to these measures, demographic information was surveyed including self-reported age, ethnicity, gender identity, most recently attended high school, high school GPA, international/first-generation student status, parents' highest level of education as a proxy for SES, and any academic accommodations students received. Additionally, for the survey given at T1, students were asked whether they had any previous experience with choice and flexibility in assessment practice (*Yes* or *No*), in addition to the frequency (*Always*, *Very Often*, *Several Times*, *Once*, *Never*), and satisfaction of such experience (*Very Satisfied*, *Somewhat Satisfied*, *Neutral*, *Somewhat Dissatisfied*, *Very Dissatisfied*).

Qualitative Experiences. For the survey administered in the intervention group at T2, a short answer section asked students to describe how the experience of being involved in assessment development made them feel, what effect it had on their perceptions of the classroom/instructor, what they enjoyed about the experience, and what might be used to improve the intervention. These questions provided qualitative data on students' experience of and suggestions to improve the intervention.

For all students at T1, perception of power was positively correlated with end-of quarter grade and attitudes towards assessment. Mastery approach was positively correlated with performance approach, performance avoidance, and attitudes towards assessment. Performance approach was positively correlated with performance avoidance.

Results

Descriptive Statistics

Corresponding means, standard deviations, and bivariate correlations of variables of interest are presented in Tables 1 and 2.

The intervention group reported general declines in all motivational orientations, attitudes towards assessment, inclination towards STEM, and end-of-quarter grades from T1 to T3. Perceptions of power increased for this group from T1 to T3. Similarly, the control group reported declines in motivational orientations and end-of-quarter grades over time; perceptions of power, attitudes towards assessment, and STEM inclination generally increased for control participants over time.

For all students at T1, perception of power was positively correlated with end-of-quarter grade percentages (r=.248, p<.01) and attitudes towards assessment (r=.307, p<.01). Mastery approach was positively correlated with performance approach (r=.306, p<.01), performance avoidance (r=.186, p<.05), and attitudes towards assessment (r=.209, p<.05). Finally, performance approach was positively correlated with performance avoidance (r=.593, p<.01).

Linear Mixed Models

In order to answer the question of whether there were significant differences of key variables of interest within participants from T1 to T3, as well as between the intervention and control groups, a random slope, linear mixed model was conducted in SPSS (V28; IBM Corp., 2017). Linear mixed models allow regression-like analysis on data that have a nested feature—in this case, students sampled from one class in their own individual discussion sections (UCLA: Statistical Consulting Group, 2021). This allowed comparison of repeated measures longitudinally without the assumption of compound symmetry (including covariance) (Magezi, 2015) and irrespective of missing data (UCLA: Statistical Consulting Group, 2021). The latter is especially pertinent to this study where not all participants were present on each data collection day (n_{T1}= 189 present, n_{T2}= 219, n_{T3}= 199) and those who were did not always complete every item during each collection point (n_{T1}= 44 incomplete, n_{T2}=

Table 1

Summary of Variable Means and Standard Deviations Over Time by Group (All: n^{T1}=189 n^{T2}=219, n^{T3}=199)

	All						Intervention						Control					
	Fall (T1)		Winter (T2)		Spring (T3)		T1		T2		T3		T1		T2		T3	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Grade (%)	99.32	5.49	96.58*	6.61	95.76*	4.44	99.73	4.62	97.55	4.70	96.16	3.67	1.00	3.92	97.87	3.41	96.22	3.41
Power	6.33	.77	6.48*	.64	6.54*	.60	6.43	.65	6.49	.63	6.63	.53	6.25	.88	6.47	.65	6.47	.64
Performance Approach	4.08	.85	3.97*	.84	3.72*	.94	4.17	.82	3.95	.83	3.87	.85	4.06	.87	3.98	.85	3.55	.99
Performance Avoidance	3.91	.99	3.81	1.04	3.62	1.07	3.95	.99	3.76	1.05	3.81	.99	3.97	.96	3.85	1.04	3.45	1.11
Mastery Approach	4.54	.55	4.45*	.63	4.43*	.62	4.61	.54	4.48	.63	4.45	.65	4.49	.52	4.41	.63	4.39	.61
Attitudes	5.09	.70	5.19	.71	5.22	.85	5.16	.76	5.14	.78	5.13	.95	5.11	.57	5.20	.68	5.24	.70
STEM	6.16	.98	6.26	.89	6.23	.90	6.24	.90	6.35	.83	6.28	.78	6.14	.97	6.11	1.02	6.19	.90

Note: *p< .01, sig. change over time; Fall as reference

Table 2

Summary of Bivariate Correlations for All Participants at T1 (n=189)

	Grades	Power	Performance Approach	Performance Avoidance	Mastery Approach	Attitudes	STEM
Grades	--	--	--	--	--	--	--
Power	.25**	--	--	--	--	--	--
Performance Approach	.04	.09	--	--	--	--	--
Performance Avoidance	.01	.09	.54**	--	--	--	--
Mastery Approach	.16	.14	.31**	.19*	--	--	--
Attitudes	.03**	.31**	.15	.14	.21*	--	--
STEM	-.10	.00	.11	.15	.08	.02	--

Note: *p<.05, **p<.01

62, n_{T3}=123). It should be noted that while there was a nested nature of participants in this study, this did not warrant the use of the multilevel command in the mixed model. This decision was made based on recommendations by Paccagnella (2011) suggesting that level-2 variables should have a minimum of 50 units to accurately estimate error. In this case, the level-2 variable—discussion section—only totaled 12 pre-and during the intervention (T1 and T2; two sections per TA) and 24 units post-intervention (T3).

Seven distinct models were run - one for each of the outcomes of interest. Perceptions of power, attitudes towards assessment, STEM inclination, grades, performance approach, performance avoidance, and mastery approach goals each served as the dependent variable in their respective model (Tables 3 and 4). The model for each outcome of interest controlled for student ethnicity (White as reference), gender (Female as reference), and self-reported high school GPA. Predictors included the academic quarter (T1-T3) and intervention group

status. Participant ID was included as a random effect in order to account for within-participant correlations.

Tables 3 and 4 show main effects of the intervention and time on variables of interest. In all, there were no significant main effects of the intervention found for any outcomes. There were significant main effects of academic quarter (time) on perceptions of power, quarter grades, and all motivation orientations of interest. Perceptions of power significantly increased for each subsequent time point (standardized β = 0.21, p=.018). All motivation orientations decreased from Fall to Spring. Mastery approach orientation decreased (β = -0.07, p=.251). Performance avoidance decreased over time (β = -0.11, p=.347) and performance approach also decreased from (β = 0.07, p=.356). Finally, grades significantly decreased from Fall to Spring from an average of 99% to an average of 95.5% (β = -0.02, p<.0001).

In all, there were no significant main effects of the intervention found for any outcomes. There were significant main effects of academic quarter (time) on perceptions of power, quarter grades, and all motivation orientations of interest.

In order to understand the effects of the intervention on specific groups within the study, the following moderators were included as interaction terms in the above-described model: ethnicity, gender, prior choice in assessment, first generation status, and TA match from Fall to Winter (Tables 5 and 6).

Table 3

Linear Mixed Model with Intervention Group Status and Longitudinal Effects Predicting Perception and Performance Variables (n=195)

	Power			Attitudes			STEM			Grades		
	B	95% CI	*p*	*B*	95% CI	*p*	*B*	95% CI	*p*	*B*	95% CI	*p*
(Intercept)	6.25	6.03 to 6.47	.000	5.09	4.86 to 5.33	.000	6.05	5.75 to 6.36	.000	1.00	.99 to 1.02	.000
Quarter[a]	.21	.04 to .39	.018	.07	-.13 to .27	.487	.03	-.18 to .24	.769	-.02	-.03 to -.01	.000
Winter												
Spring	.23	.03 to .44	.027	.16	-.08 to .39	.188	.03	-.22 to .28	.827	-.03	-.04 to -.03	.000
Intervention Group[b]	.17	-.04 to .38	.118	.05	-.18 to .29	.641	.08	-.21 to .27	.585	.00	-.01 to .01	.619
Ethnicity[c]	-.06	-.36 to .23	.669	.33	.02 to .64	.037	-.19	-.62 to .23	.371	-.03	-.05 to -.01	.002
Latinx/Black												
Multiethnic	.03	-.22 to .29	.795	.01	-.26 to .28	.954	-.02	-.39 to .35	.929	.00	-.01 to -.02	.581
E/S Asian	.02	-.27 to .21	.809	.12	-.08 to .32	.257	-.02	-.29 to .26	.907	.01	-.01 to .02	.298
Gender[d]	-.08	-.25 to .09	.361	-.12	-.29 to .06	.191	.22	-.02 to .46	.073	-.01	-.02 to .00	.015
HS GPA	.00	-.01 to .01	.344	.00	-.01 to .01	.419	.01	-.01 to .02	.465	.00	.00 to .00	.428
Quarter*	-.12	-.37 to .13	.342	.00	-.28 to .28	.994	.13	-.16 to .43	.383	.00	-.01 to .01	.694
Intervention Group												
Winter*Int												
Spring*Int	-.06	-.35 to .24	.711	-.15	-.48 to .17	.353	-.04	-.39 to .32	.832	.00	.00 to .01	.838

Note: [a]Fall=reference, [b]Intervention group=reference, [c]White/Caucasian/Middle Eastern = reference, [d]Female=reference

Table 4

L*inear Mixed Model with Intervention Group Status and Longitudinal Effects Predicting Motivational Orientations (n=195)*

	Mastery Approach			Performance Avoidance			Performance Approach		
	B	95% CI	*p*	*B*	95% CI	*p*	*B*	95% CI	*p*
(Intercept)	4.72	4.52 to 4.92	.000	4.12	3.77 to 4.46	.000	4.27	3.70 to 4.57	.000
Quarter[a]	-.07	-.18 to .05	.251	-.11	-.33 to .12	.347	-.07	-.23 to .08	.356
Winter									
Spring	-.09	-.23 to .04	.186	-.38	-.65 to -.11	.006	-.50	-.69 to -.31	.000
Intervention Group[b]	.05	-.13 to .23	.597	-.05	-.37 to .27	.769	.07	-.21 to .34	.623
Ethnicity[c]	.04	-.25 to .32	.795	-.02	-.46 to .51	.926	-.14	-.58 to .29	.507
Latinx/Black									
Multiethnic	-.05	-.29 to .20	.710	-.15	-.58 to .27	.475	-.31	-.68 to .07	.108
E/S Asian	-.12	-.30 to .07	.210	-.22	-.54 to .09	.165	-.27	-.55 to .01	.055
Gender[d]	-.41	-.57 to -.25	.000	-.12	-.40 to .16	.392	-.17	-.42 to .08	.173
HS GPA	.00	.00 to .01	.470	.01	-.01 to .03	.304	.01	-.01 to .02	.291
Quarter*Intervention Group	-.04	-.21 to .12	.596	.02	-.30 to .33	.919	-.02	-.25 to .20	.831
Winter*Int									
Spring*Int	-.10	-.30 to .09	.299	.30	-.08 to .68	.119	.16	-.11 to .43	.240

Note: [a]Fall=reference, [b]Intervention group=reference, [c]White/Caucasian/Middle Eastern = reference, [d]Female=reference

While the intervention did not have overall effects for all students in this context, there were promising moderator effects on perceptions of power for those who had a new TA during intervention implementation, as well as on performance approach orientations for first generation students.

Table 5
Linear Mixed Model with Intervention Group and First Gen Status Interaction Predicting Performance Approach Orientation

	B	95% CI	*p*
(Intercept)	4.15	3.64 to 4.66	.000
Quarter[a]	-.09	-.20 to .02	.123
Winter			
Spring	-.42	-.55 to -.29	.000
Intervention Group[b]	.84	.25 to 1.42	.005
Ethnicity[c]	-.32	-.84 to .20	.231
Latinx/Black Multiethnic	-.36	-.73 to .01	.059
E/S Asian	-.31	-.59 to -.03	.031
Gender[d]	-.13	-.37 to .11	.297
HS GPA	.01	-.01 to -.02	.210
First Gen[e]	.16	-.29 to -.61	.484
Intervention*First Gen	-.87	-1.51 to -.24	.007

Note: [a]Fall=reference, [b]Intervention group=reference, [c]White/Caucasian/Middle Eastern = reference, [d]Female=reference [e]First Gen students=reference

Table 6
Linear Mixed Model with Intervention Group and First Gen Status Interaction Predicting Performance Approach Orientation

	B	95% CI	*p*
(Intercept)	6.20	5.97 to 6.42	.000
Quarter[a]	.15	.03 to .27	.016
Winter			
Spring	.20	.06 to .35	.006
Intervention Group[b]	.24	.03 to .45	.024
Ethnicity[c]	-.07	-.37 to .22	.618
Latinx/Black Multiethnic	.04	-.21 to .30	.751
E/S Asian	.01	-.18 to .20	.940
Gender[d]	-.05	-.22 to .12	.563
HS GPA	.00	-.01 to .01	.401
TA Match[e]	.19	-.05 to .43	.116
Intervention*TA Match	-.35	-.69 to .00	.048

Note: [a]Fall=reference, [b]Intervention group=reference, [c]White/Caucasian/Middle Eastern = reference, [d]Female=reference [e]No TA Match=reference

A marginally significant interaction with intervention group and first-generation students was found for performance approach orientation (Figure 2). Additionally, a marginally significant interaction of intervention group with whether TAs changed from Fall to Winter on perceptions of power (Figure 3). For those in the intervention group, there was a predicted .84 increase in first generation student performance approach orientation versus first generation students in the control group ($\beta = 0.84$, $t = 2.83$, $p = .005$). For those in the intervention whose TAs changed from Fall to Winter, there was a predicted .24 increase in reported perception of power ($\beta = 0.24$, $t = 2.28$, $p = .024$).

To sum, while the intervention did not have overall effects for all students in this context, there were promising moderator effects on perceptions of power for those who had a new TA during intervention implementation, as well as on performance approach orientations for first generation students.

Figure 2
Differential effect of intervention for first generation students in intervention group vs. control on performance approach orientation

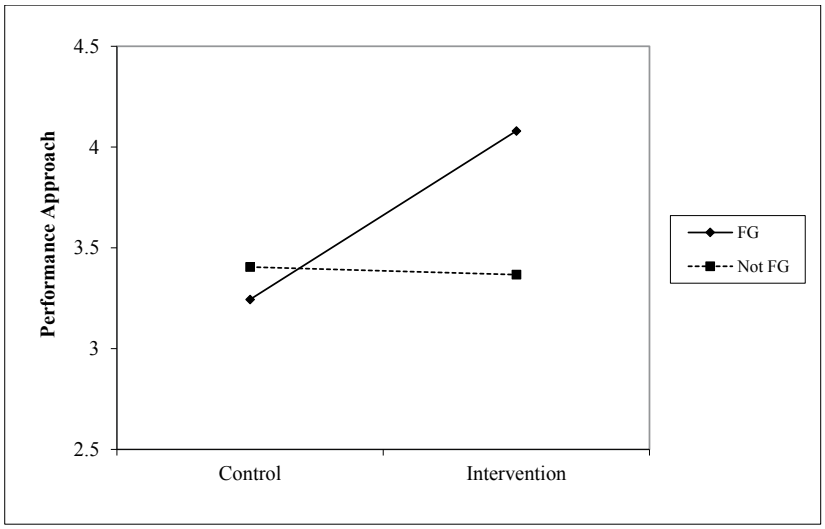
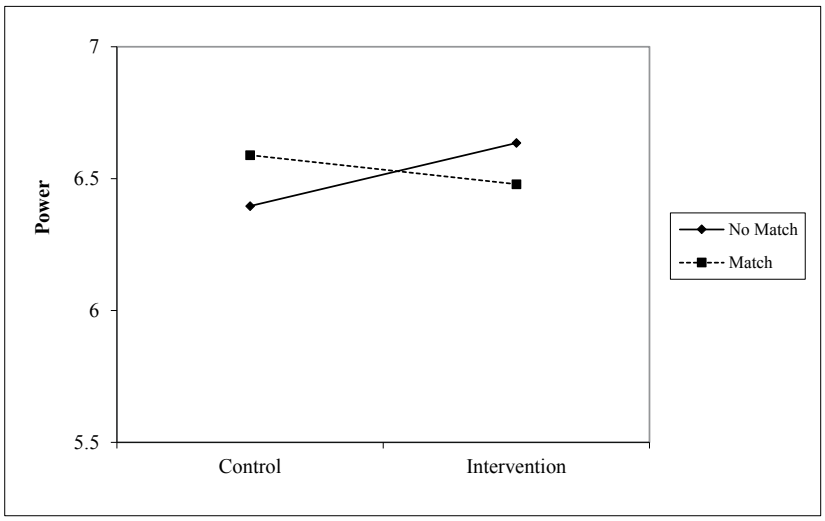


Figure 6
Differential effect of intervention for students with no TA match versus TA match on perceptions of power



Open Ended Responses

Intervention Group Students. In addition to gauging student experience and perception of the intervention with quantitative surveys, participants also had an opportunity to respond to open-ended questions about their experience. Responses were first filtered by whether the question was answered relative to the intervention itself (as prompted) or in regards to the class as a whole (omitted for these analyses). Sixty-nine participants answered at least one of the three prompts in relation to the intervention. In response to the first question of how the intervention made students feel, the following words were most commonly used: reflect/reflective (6), power/empowered (6), comfortable (3), control (4), heard (4), and included (2). In one student's words:

> "Although it was very short, I believe that it's a great technique to really establish that sense of learning within students. It places students at the center of their own success and achievement and that's really-really important for First Years and for students in general to be able to own up their own learning."

In response to the first question of how the intervention made students feel, the following words were most commonly used: reflect/reflective (6), power/empowered (6), comfortable (3), control (4), heard (4), and included (2).

This was echoed in other responses that appreciated "having the autonomy to be able to implement [their] personal goals onto the grading criteria," and citing the experience as making them "feel very included and welcomed into [school name]."

In light of a lack of quantitative main effects of the intervention, these responses suggest that perhaps co-creation of participation criteria, while positive, was not enough to override motivation and perceptions of assessment overall.

While the majority of responses were positive, there were participants who cited neutral or contrasting stances to the experience. For example: "It made me a little bit unsure about the grading at the same time since I am so used to teachers providing a grade just based on the amount of participation." In a similar vein, one student cited they "did not like it that much," and that "teachers should set the criteria and you should strive to meet those standards." Others found it "very nonchalant," and "unique" but not "particularly impactful."

In response to the second question of what effects engaging in the intervention had on students' perceptions of the classroom and/or their instructor, responses were again generally positive. One student responded that the classroom "felt more open and understanding, as more of a community rather than a prison." Another said the intervention showed the instructors as "accepting/trusting (treating us like adults haha)," while another said it showed the instructor "wasn't a tyrannical-stuck-up instructor." To sum for one student, the intervention helped show the classroom "as though I and the other students matter as people and have identities as such, rather than just as students. I felt that I could go to my instructor without judgment as well."

Finally, students were asked what could be improved about the intervention process (Table 7; *n*=28). A bulk of participants cited "N/A," "not sure," or something synonymous to "process was quite good" (*n*=13). Suggestions for improvement included: having a more specific rubric of how each "subsection" of criteria mapped on to graded points, a reminder of the criteria more often throughout the quarter, and opportunity for "self-checks." This was echoed in another comment with a student saying perhaps TAs can provide the "distinct categories of guidelines" and students could fill-in with criteria.

Table 7
Intervention Improvement Suggestions from Students (n=28)

- Post finalized criteria in publicly available space (i.e., CCLE)
- Quantify each subsection for grading purpose/clarity
- Allow participation self-checks/self-assessment
- Have participation grades available for viewing all Quarter
- More guidance in creating the criteria/provide guiding purposes
- More frequent check-ins about criteria and opportunity to adjust

Intervention Group TAs. While students were the main focus of this intervention, TAs were also surveyed as to their experience implementing the intervention in order to understand the instructor perspective as well. The three intervention TAs completed a short questionnaire at the end of T2 about their experience conducting the intervention. The first question asked what TAs saw as the positive outcomes of co-creating criteria for participation with their students. In the words of one TA: "I think students are more relaxed about participation in that they don't feel like they have to be the most talkative one, and they feel more in control."

The second question asked about the challenges TAs perceived in co-creating criteria for participation. Only one TA responded to this question explaining that this process was "more difficult than creating criteria myself because it requires facilitating a longer discussion."

The final question asked TAs how the experience of co-creating criteria with their students made them feel. One TA said it gave them a "better understanding of how the students experienced class…especially on Zoom," while another said "I like giving some of the authority and control to the students, as well as making the assessment more transparent." The last TA said they had already shared the idea with a community they were teaching with next quarter in attempts to "help build trust" with students.

In light of a lack of quantitative main effects of the intervention, these responses suggest that perhaps co-creation of participation criteria, while positive, was not enough to override motivation and perceptions of assessment overall. In other words, it may seem that student voice is needed in more content-based assessment practice in the classroom (a larger portion of the overall grade) in order to potentially see larger classroom effects. Finally, these student and TA responses combined to help demonstrate a more symbiotic relationship relative to power dynamics in the classroom–one where instructors and students appear to be on the same pedagogical team rather than pitted against one another in a struggle for potential power.

Discussion & Limitations

The current study sought to longitudinally understand the effects of an intervention that engaged student voice in classroom assessment practice on perceptions of power, attitudes towards assessment, motivational orientation, STEM inclination, and academic performance. The significant main effect of time on students' perceptions of power in the classroom and motivational orientation point to the importance of studying student experience long-term rather than cross-sectionally. Across the motivational orientations (mastery approach, performance approach, and performance avoidance), all students experienced a steady decline from Fall to Spring. This finding is consistent with literature demonstrating a general decline in student motivation over the academic school year (Corpus et al., 2009) and may point to the fatigue of the academic year– particularly in the fast-paced, 10-week quarter system. This was compounded by the toll of the global pandemic coupled with online learning (Lopez & Tadros, 2023). The gradual increase in student perceptions of power from Fall to Spring for all participants contrasts the motivational decline over time and echoes research that suggests a correlation between increased experience in college and increased feelings of empowerment (Clark, 2005). In this particular context, the increase was perhaps a result of the consistent instructional staff that carried over from quarter to quarter which made it easier for students to have their voice heard.

For those first-generation students in the intervention who reported an increase in performance approach as compared to their control peers, this finding suggests some motivational promise in incorporating student voice into assessment for those who are new to the nuances of higher education (and the assessment practices that accompany it).

To address the primary outcome, the intervention did not have significant main effects on any of the outcomes of interest. This was likely due to a couple of factors. For one, this course was far from what might be considered a "traditional" STEM course. Relative to assessment practices, the course did not curve grades. Moreover, the very content of this STEM course was interdisciplinary. The course sought to view this particular STEM field through the lens of "technical, political, cultural, and social dimensions." Thus, both the content and grading policies set this course apart from those that might be viewed as more typically rigid in nature (as was the case in the pilot implementation of the intervention [Chase, 2020]).

The bias in sample availability may also have been a factor here. Finding instructor-collaborators in STEM for this work took several years; the instructor who was willing to allow their classroom to be used for this intervention, was one who was already quite invested in advancing equity through their pedagogical practices. Thus, a limitation here was the availability of working with a "traditional" STEM course/instructor. This is potentially because those who may not yet necessarily see the value in innovating their pedagogy were the same instructors who were not yet open to collaborating and incorporating this intervention into their course (and yet, may have had their course benefit the most given this intervention).

The intervention did, however, have modest significant effects for certain groups of students, although care must be taken in interpreting these findings given the number of tests run. For those first-generation students in the intervention who reported an increase in performance approach as compared to their control peers, this finding suggests some motivational promise in incorporating student voice into assessment for those who are new to the nuances of higher education (and the assessment practices that accompany it). Performance approach has been shown to be important in the persistence and "bounce-back" for students who experience failure, thus, an advantageous orientation to align with (Sideridis & Kaplan, 2011). These findings were similar for those intervention students whose TA changed from Fall to Winter and reported an increase in perceptions of power in the classroom. While it

In all, the current study provides preliminary evidence towards the importance of seeking novel and meaningful ways to engage students as partners in classroom assessment practices; not simply to accommodate for adjustments of hybrid or online learning, but more importantly, to continue to question the ways classroom assessment may serve as a mechanism for equitable classroom spaces and student success.

was hypothesized that students with the same TA who experienced the intervention would experience significant increases in perceptions of power (due to familiarity with the TA), this finding suggests otherwise. It may be that when students encounter a new classroom with a new instructor (as is typically the case from quarter to quarter) this intervention may increase perceptions of power in that classroom space. In the context where the content of the course stayed the same, the only difference was a new TA. These interaction findings demonstrate the potential stabilizing factor that the intervention may serve for students in new contexts.

Future practice should look to implement the intervention in the context of a more traditional STEM course. It may be useful to expand outcomes such as seeking to understand what effects such an intervention might have on other important psychosocial by-products of supporting student autonomy in the classroom such as self-efficacy, views of intelligence, and anxiety/stress which was often reported as a mental-emotional toll of current assessment practice. Additionally, given no significant correlation in this study between perceptions of power and motivational orientations, I recommend the use of a motivational measure which more closely aligns with autonomy and autonomous motivation, e.g., Motivated Strategies for Learning Questionnaire (Pintrich, 1991) rather than goal-oriented measures used here which are treated as antecedents of intrinsic/autonomous motivation in the literature (Elliot et al., 2011). Finally, it may be beneficial to explore this intervention with under-represented student populations. While the current study did explore potential interactions with student ethnicity or gender, a larger sample size may be necessary to highlight? these differences. The ultimate aim and suggestion here is for student voice to extend beyond participation to more meaningful content-based, assessment practice.

All in all, while the intervention did not have a significant effect for all, students' open-ended responses demonstrated a qualitatively positive experience. In the words of one student, the intervention made them feel: "kind of empowered. I felt heard and that my contribution mattered. It made me feel like I need to take up more responsibility because we came up with these criteria ourselves, which I think is a good thing!" This comment points to the initial hypothesis during the conception of this study, such that student voice in classroom assessment practice may motivate student achievement via perceptions of power and autonomy. These findings are also in line with current research and practice boasting the effects of 'student as partners' work in higher education (Cook-Sather et al., 2018).

Finally, I would like to discuss a lurking set of conditions during data collection and intervention use: online learning plus the global pandemic. For participants, this was likely their first college classroom, and it being exclusively online ('Zoom university') and physically separated from the larger campus community. Add to this the widening inequities exposed by the effects of the global pandemic (i.e., increased work and family responsibilities, particularly marginalized students, technological access issues, etc.). These conditions helped highlight the need for such an intervention wherein the pandemic forced instructors to rethink what was formerly taken for granted in "traditional" classrooms. The intervention helped clarify assessment criteria for participation *in an online format*, which was otherwise not something most had dealt with in higher education. In the words of one student: "I felt really supported which eased the online learning experience."

Additionally, this intervention uncovered subtle inequity in current participation criteria for *in-person* classrooms. One student describes:

> "I enjoyed this because as someone with severe social anxiety it didn't make me feel pressured to be constantly speaking, in turn making me anxious about coming to discussion. It also made me feel like I matter and my opinion is in fact important."

This student points to the assumed participation criteria in in-person classrooms that synonymize participation with "constantly speaking." The path for obtaining academic accommodations is strewn with barriers for students with disabilities (Toutain, 2019); thus, classroom assessment practice (including participation evaluation) may disadvantage those with "hidden" disabilities or those who do not have formally requested accommodations. This points to yet another reason why student voice in classroom assessment practice is inevitably a necessity towards the aim of creating more equitable classrooms.

In all, the current study provides preliminary evidence towards the importance of seeking novel and meaningful ways to engage students as partners in classroom assessment practices; not simply to accommodate for adjustments of hybrid or online learning, but more importantly, to continue to question the ways classroom assessment may serve as a mechanism for equitable classroom spaces and student success.

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Appendix A
Survey Items (including Intervention Group Open-Ended Items)

Class Climate Survey

The following survey is being administered to understand student perceptions of the class climate in discussion sections. Your participation is voluntary and is completely anonymous.

Part I
Think about the way you are assessed by your TA in the discussion section and respond to the following prompts in regards to that assessment experience:

1. I feel that my TA provides me choices and options.
2. I feel understood by my TA.
3. My TA conveyed confidence in my ability to develop assessment criteria.
4. My TA encouraged me to ask questions.
5. My TA listens to how I would like to do things.
6. My TA tries to understand how I see things before suggesting a new way to do things.

Part II
Please respond to the following prompts:

1. My aim is to completely master the material presented in this class.
2. I am striving to do well compared to other students.
3. My goal is to learn as much as possible.
4. My aim is to perform well relative to other students.
5. My aim is to avoid learning less than I possibly could.
6. My goal is to avoid performing poorly compared to others.
7. I am striving to understand the content as thoroughly as possible.
8. My goal is to perform better than the other students.
9. My goal is to avoid learning less than it is possible to learn.
10. I am striving to avoid performing worse than others.
11. I am striving to avoid an incomplete understanding of the course material.
12. My aim is to avoid doing worse than other students.

Part III
Please respond to the following prompts:

1. I liked how the grading scheme employed in this course, with respect to participation, was determined.
2. I believe that allowing a student to choose the criteria assigned to different components in their grading scheme (e.g., class participation) can help the student achieve a higher grade in the course.
3. I believe that allowing a student to choose the criteria assigned to different components in their grading scheme (e.g., class participation) will likely increase the student's total work effort in the course.
4. I believe that allowing students to participate in designing the grading scheme in a course wastes students' time that could be better spent working on the course material.
5. If students are allowed to choose the criteria assigned to different components in their grading scheme (e.g., class participation), I believe they will be more likely to neglect some course activities that would be beneficial to them.

Part IV

1. I feel comfortable engaging with STEM (Science, Technology, Engineering, or Math) content.)
2. I am interested in pursuing a STEM (Science, Technology, Engineering, or Math) major.
3. I feel I will succeed as a STEM (Science, Technology, Engineering, or Math) major.

Appendix A
Survey Items (including Intervention Group Open-Ended Items) Cont.

General Feedback

Use the space below to reflect on the experience of creating the criteria for participation evaluation.

1. How did this experience make you feel?
2. What effects did being engaged in this process have on your perceptions of the classroom and/or instructor?
3. What worked about this process? Similarly, what didn't?
4. How could this process be improved?

Appendix B
Process Data Sample of Students' Purposes of Participation Assessment Responses

Appendix C
Process Data Sample of Students' Behavioral Criteria for Participation Responses

Collaboration

- Thoughtful and respectful interactions with our peers, Being friendly and open to listening to others, Spirit of reciprocity/empathy in order to further understanding
- Contributing to full-class discussions in section, on Perusall, in breakout rooms
- Sharing your ideas (such as in this doc)
- Pay attention to what others are saying rather than focusing on what you will say next→ active listening
- Building ideas off of what peers have already shared, Bringing together concepts from everyone's perspective, Building off of each other's skills
- Consider everyone's ideas/skills
- Working together to understand material and new concepts
- Encouraging/ welcoming others to participate if they seem to be left out of the discussion

Communication

- Talking in breakout rooms, in full class discussions, in chat, emailing TA, attending OH, Using slack/email if necessary
- Exchanging various perspectives while also having a desire to understand why they believe the things they do
- Challenging your own beliefs
- Being available and open for questions (ie groupme/ in a groupchat if needed)
- Answering peers' questions
- Speaking/recognizing new ideas, Presenting new ideas in a clear and concise way
- Providing practical examples
- Being comfortable with being wrong sometimes and open to other ideas.
- Ask for clarification if needed

Engagement

- Filling out google docs and completing assignments, Be prepared for class (Pre-Class Assignments)
- Being mentally present during discussion sections
- Desire for clarity and growth
- Asking any questions if needed! Nothing is stupid to ask
- Participating in ice breakers
- Asking and answering questions
- Responding to others comments
- Answering questions
- Critical thinking
- Be on time and minimize distractions
- Answering polls on Zoom
- Actively listening and responding with thoughtfulness
- Giving your best effort always

Appendix D
Process Data Sample of Finalized Discussion Section Participation Grading Criteria

Collaboration	Communication	Engagement
• Thoughtful and respectful interactions with peers, practicing empathy • Contributing to full-class discussions in section, on Perusall, in breakout rooms • Sharing your own ideas • Actively listening to your peers • Building off of your peers' ideas • Recognizing others' skills and expertise • Encouraging others to participate when they seem left out	• Talking in breakout rooms, in full class discussions, in chat, in polls, in icebreakers, in Slack, emailing TA, attending OH • Exchanging various perspectives with a desire to understand others • Challenging your own beliefs and being open to questions • Acknowledging others' questions or new ideas • Asking for clarification • Providing practical examples	• Completing pre-class and in-class assignments and readings • Being mentally present during section and on time • Asking questions or commenting on others' ideas • Growing throughout the quarter • Critically analyzing material • Giving your best effort • Actively listening to your peers