PROMOTING INCLUSION AND A SENSE OF BELONGING IN A NEW INTRO STATS COURSE

Shu-Min Liao
Amherst College, Massachusetts, USA.
sliao@amherst.edu

Public concerns about students' mental health have been rising across the past decade. In response to local and national calls for institutions of higher learning to attend to student well-being and social inequities, we created a new course named "Happy Intro Stats" (HIS) at our U.S.-based liberal art college in Fall 2022. This is an interactive and fully inclusive introductory statistics course designed to address the importance of self-care on mental health and help students understand inequities in mental health status and access via statistical investigations. A comparative study is conducted between this new HIS course and our traditional intro stats course, taught by the same instructor in the same semester. The impact of embedded self-care practices and inclusive pedagogies on undergraduate student mental health and learning – especially how those intentional designs promote inclusion and students' sense of belonging in a statistics classroom – is investigated in this paper.

INTRODUCTION

Public concerns about U.S. students' mental health and emotional well-being have been rising across the past decade. For instance, Nature's 2019 global survey of PhD students in sciences revealed that over one-third (about 36%, compared to 12% in their 2017 survey) of the respondents admitted that they had sought help for depression or anxiety caused by PhD studies (Woolston 2019). The mental health crisis has been further compounded by the unprecedented COVID-19 pandemic; this prolonged stressor has taken a profound toll on the lives and wellness of mankind, and many researchers have called for increased support for U.S. college student mental health (e.g. Copeland et al. 2021). While those studies focus on U.S. students, it is reasonable to assume that the pandemic has introduced additional stressors to all students and human beings across country borders.

To address the continued impacts of the pandemic on student mental health, many innovative approaches have been explored. For example, Lin et al. (2020) studied and discovered positive relationships between various *self-care practices* and *resilience* among students, faculty, and staff affiliated with the health professional schools in Texas; these scholars advocate for adding self-care practices within the curriculum. Likewise, two neuroscientists at University of Michigan introduced a mindfulness course integrating the practices of yoga and meditation to their neuroscience program and found that this intervention was helpful in improving student well-being (Boehnke and Harris 2021). These self-care practices are known to enhance overall *happiness* (Merlo 2021) and align with the larger conversation around student success. However, the literature has identified the largest obstacles for students seeking professional help for mental illness are: (1) the deeply-rooted stigmas in our society, and (2) student tendencies not to consider professional help until urgently needed (Brown 2018). To respond to local and national calls for higher education to attend to student well-being and social inequities, we seek to integrate self-care practices and promote student awareness of mental health stigmas in our statistics curriculum, which led to the birth of a new intro stats course.

NEW COURSE: HAPPY INTRO STATS

Created and taught for the first time in Fall 2022, this new introductory statistics course is named "*Happy Intro Stats*" (HIS in short, a.k.a. STAT 136) and is an interactive and fully inclusive course designed to address the importance of self-care on mental health and help students understand inequities in mental health status and access via statistical investigations. It is "fully inclusive" in the sense that this course is offered with minimum barriers – no prerequisites, no expectations on prior coding experience, and no costs for the textbook and software – and maximum support through student-centered designs and inclusive pedagogies. More specifically, this Happy Intro Stats (HIS) course is different from our existing intro stats course (named "*Intro to Stat Modeling*" and listed as STAT 135) – which requires calculus as a prerequisite, uses a pricey textbook, and is taught without some inclusion-oriented interventions – in that:

- HIS imposes *no prerequisites*, so students with *all* backgrounds – STEM or not – are welcome and can take it at any point during their time at our U.S.-based liberal art college.
- HIS uses an *open-access textbook*, "Introduction to Modern Statistics", which is always available for free online, along with weekly supplemental readings for mental-health related topics.
- Although HIS (STAT 136) and STAT 135 (our existing intro stats course) both use R (a free statistical software) for programing and expect students to have no prior coding experience before taking either class, HIS begins students' coding journey with an innovative blocked-based visual coding tool (which we will cover in a separate paper) before moving to syntax-based R language. It is our belief that this *inclusive coding tool* not only minimizes the learning barriers embedded in syntax-based coding for R novices but also boost students' coding self-efficacy, especially for those from equity-seeking groups and disadvantaged families, from the very beginning.
- To further ensure that students with less math training can succeed in HIS, we choose to teach statistical inference procedures in HIS (STAT 136) using *simulation-based approaches* (bootstrap confidence intervals and randomization tests), rather than using the traditional theory-based (normality-based) methods as in STAT 135.
- In HIS, we begin the course by inviting all students to 1) examine their mental health stigmas and practice *weekly self-care exercises* together with us in order to train everyone's "happy muscles"; and 2) simultaneously discover the scientific evidence behind those self-care practices and explore existing disparities in mental health care systems via weekly readings and in-class discussions.
- When designing this new course, we implement so-called "*students as partners*" practice and hire two statistics-majored students (both of whom are women of color) as academic interns to brainstorm and co-create course materials for HIS, to integrate their perspectives in the core of the course and ensure that HIS is not only student-centered but also student-driven. All the readings, discussion topics, datasets used in class examples and R activities, as well as the schedule and structure of the HIS course are sweet fruit from such student-faculty partnership.
- Furthermore, all students in HIS, regardless of their backgrounds and identities, are encouraged to share their opinions in class, take their share of responsibility, and play an active role as a *student partner* in co-creating the course and co-building an inclusive learning community with their peers and the instructor. We dedicate in-class time for community building (e.g. taking time to co-create "community norms" to satisfy diverse learning needs from all the students in the beginning of the semester, allowing for regular check-ins/ buddy time in class, etc.) and offer effective means of fostering good relationship and collaboration among students (e.g. forming "study/accountability groups", each of which creates their own "group agreement form" and "collaboration plan" during the first week and revisits/revises those documents a few times through the semester, etc.). We and two interns also provide small-group or individual support regularly outside of class.
- While we use multiple surveys through the semester to solicit student feedback from both courses, HIS students have additional access to an *anonymous online survey* for sharing their thoughts; in addition, they can also provide feedback through the course interns.

Additional inclusive teaching pedagogies we integrate in both courses under comparison can be found in Liao et al. (2022) and Liao (2023).

While this new HIS (STAT 136) course integrates intentional pedagogical designs in teaching and incorporates mental health practices in learning, we should address that HIS (STAT 136) satisfies the *same* requirements as the traditional STAT 135 in our statistics curriculum; both courses are listed as an eligible pre-requisite for our core intermediate statistics course and other 200-level electives.

COMPARATIVE STUDY

A comparative pilot study based on multiple surveys collected through Fall 2022 is conducted between the new HIS course (STAT 136) and our existing intro stats course, STAT 135, both of which were taught by the same instructor in the same semester. Drawing from the *self-determination theory* – which focuses on social-contextual conditions that foster students' engagement in meaningful learning – and other literature on inclusive teaching practices, we investigate the impact of the embedded self-care exercises and inclusive pedagogies on undergraduate student mental health and learning in a statistics classroom setting. The study aims to examine (1) how such course may make a difference in

students' statistical learning and happiness over the course of a semester, and (2) whether those intentional designs may help promote inclusion and students' sense of belonging in an intro stats course.

Theoretical Framework

According to the overview of Deci and Ryan (2008), "*Self-determination theory (SDT) is an empirically based theory of human motivation, development, and wellness,*" finding that "the degrees to which basic psychological needs for *autonomy*, *competence*, and *relatedness* are supported versus thwarted affect both the type and strength of motivation." SDT differentiates types of motivation as three: autonomous motivation, controlled motivation, and amotivation, and research has shown that autonomous motivation tends to "yield greater psychological health and more effective performance on heuristic types of activities" (Deci & Ryan, 2008). Furthermore, autonomous motivation comprises both intrinsic motivation and two specific forms of extrinsic motivation – integrated regulation (regulation assimilated to one's sense of self) and identified regulation (identification reflecting a conscious valuing of a regulation or an action) – and can only be achieved when the three basic psychological needs mentioned above - autonomy, competence, and relatedness - are satisfied (Deci & Ryan, 2008; Ryan & Deci, 2000). Following the definitions given by Ryan and Deci (2000), the need for *relatedness* refers to a sense of belonging and feeling connected to people, group, community, or culture; in classrooms, this means that students feel respected and cared for by the teacher. The second need concerns perceived c*ompetence*, which is defined as one's feelings of efficacy with respect to an extrinsic goal or confidence to take on a challenging task; it is one's sense of enabling and students are more likely to internalize a goal or adopt a challenge if they feel that they have required skills to complete it successfully. The last basic need is *autonomy* support, which is in fact "the critical element for a regulation being integrated rather than just introjected" (Ryan & Deci, 2000); in other words, autonomy is one's sense of agency.

In this pilot study, SDT provides a good theoretical frame for investigating the experiences of HIS students. It is our belief that the integrated inclusive pedagogies in the HIS course promote students' sense of belonging (relatedness) and the intentional student-centered designs help facilitate students' sense of agency (autonomy). Moreover, designing this course "from the margins" and offering it without any prerequisites or expectation on prior coding experience also greatly enlarge students' confidence (competency) to engage and thrive in HIS. Not to mention that practicing weekly self-care exercises with their professor and peers while learning scientific evidence behind those practices may further teach HIS students important lessons in their statistical work and daily life.

Participants and Surveys

There were 25 students enrolled in HIS (STAT 136) and 23 in STAT 135 in Fall 2022, 24 of whom in HIS and 19 in STAT 135 granted us permission via IRB consent to use their data for this pilot study; the participation rates between HIS and STAT 135 are 96% vs. 82.6%. It is worth noting that, among 24 students in HIS, only 3 students (12.5%) are majored in, or potentially majored in, data science related fields (i.e. statistics, mathematics, or computer science), and 14 are STEM-related (i.e. 10 out of 24 are non-STEM students). On contrary, 11 out of 19 students (about 58%) in STAT 135 are majored in data science related fields and 17 out of 19 are STEM-related (i.e. only 2 out of 19 are non-STEM students). It might be fair to say that the new HIS course has successfully attracted a decent number of "non-traditional" intro stats students.

Participating students are asked to fill in three surveys through the semester: the first one is the First-Day Survey, the second one is the Mid-Semester Survey (collected at the end of Week 7), and the last one is the End-of-Semester Survey (collected at the end of Week 14). The First-Day Survey include common demographic and background questions, as well as some questions related to students' self-reported happiness levels and self-care habits. In the Mid-Semester Survey, we mainly ask students to reflect on their learning by far in class and check on their feeling of happiness in the middle of the semester. We then check on students' happiness levels and self-care practices again in the End-of-Semester Survey, along with some questions on student sense of belonging and inclusion, adapted from Leibowitz et al. (2020).

Results and Findings

The first research question of interest is whether this new intro stats course, HIS, makes a discernible difference in students' statistical learning, compared to our existing course, STAT 135. Given that two courses were taught by the same instructor in the same semester and followed similar grading schemes and scales, we compare students' statistical learning using their course final grades and averages. Figure 1 and Figure 2 show distributions of students' final grades and final averages between two courses, STAT 135 and STAT 136 (HIS), respectively.

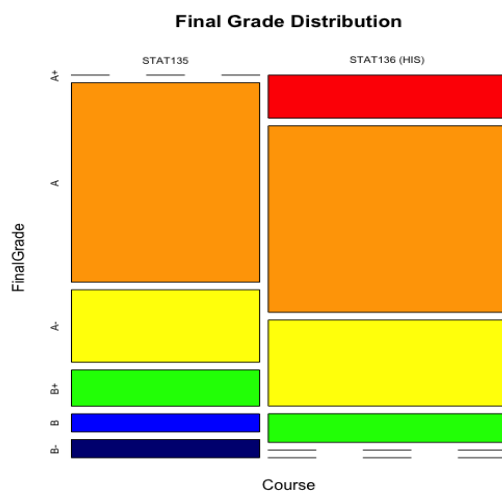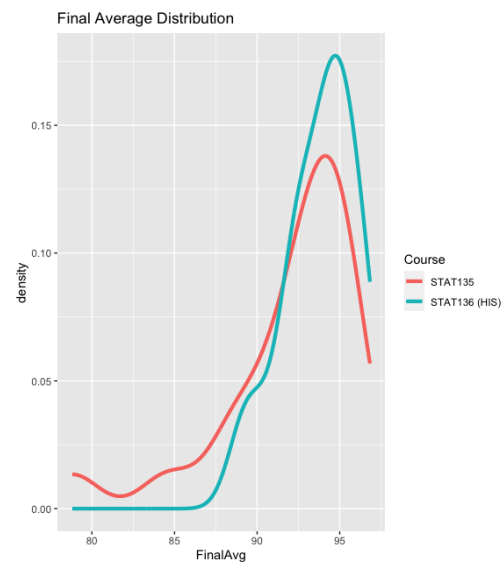Figure 1. Student Final Grade Comparison   Figure 2. Student Final Average Comparison

We are delighted to report that students in HIS seem to perform better than those in STAT 135 – there are three students receiving A+ in HIS versus none in STAT 135; on the other hand, there are two students in STAT 135 receiving a final grade lower than B+ (more specifically, one B and one B-) versus no one in HIS receiving such grades. Students' final averages are discernibly higher in HIS than in STAT 135 at an alpha-level of 0.1 (Mann-Whitney test, p-value = 0.064). We should further point out that one of the four students in STAT 135 who didn't participate in the study in fact failed the course (receiving an F at the end), so the actual difference in student performances between two courses should have been more extreme than what appears in the above graphs.

Next, we compare students' self-reported happiness levels for Spring 2022 and Fall 2022. In the First-Day Survey, students in both classes were asked, "Overall, on a scale of 0 to 10, how would you rate your happiness level LAST semester (Spring 2022)?" and we find no statistical significance in students' responses to their happiness level in Spring 2022 between two courses (Mann-Whitney test, p-value = 0.55). However, when we asked students to evaluate their overall happiness level over Fall 2022 in the End-of-Semester, the result becomes statistically significant at an alpha-level of 0.1 (Mann-Whitney test, p-value = 0.055). Since self-reported happiness levels are quite subjective, we further compare students' happiness level for Fall 2022 with their own response for Spring 2022 to see if they become happier over the course of a semester. Figure 3 displays the corresponding results. Similarly, we also asked students to answer "on average, how many times per week do you usually practice self-care?" in the beginning and at the end of the semester, and examined if they increase self-care times per week over the course of a semester. Figure 4 displays the corresponding results.

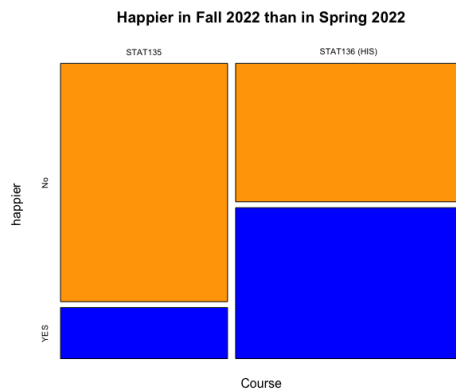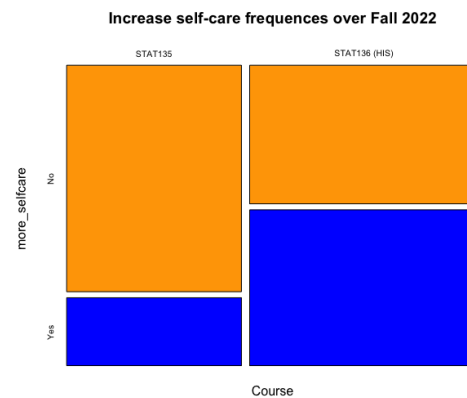Figure 3. Proportion of Happier Students   Figure 4. Students increasing self-care times

Noticeably the proportion of students in STAT 136 (HIS) who feel happier in Fall 2022 than in Spring 2022 is discernibly greater than that in STAT 135 (Fisher exact test, p-value = 0.027). Similarly, the proportion of students in STAT 136 (HIS) who increase the number of times per week for self-care practices over the course of Fall 2022 is somewhat greater than that in STAT 135 (Fisher exact test, p-value = 0.1). While we can't make a strong cause-effect conclusion here, the embedded weekly self-care practices have seemed to motivate more HIS students to care about themselves, which may (or may not) explain why more students in HIS than in STAT 135 rate their happiness level higher in the fall than in the spring of 2022. After all, 20 out of 24 (83.33%) participating students in HIS agreed in their Mid-Semester Survey that reading about the empirical research on self-care practices has increased their likelihood of engaging in those exercises.

In the End-of-Semester Survey, students in both courses were asked to use a 7-point Likert-scale, ranging from "Strongly Disagree" to "Strongly Agree", to respond to several items concerning student sense of belonging and inclusion, two of which are:

- Item 1: Overall, I feel a sense of belonging in this class.
- Item 2: Overall, I feel the learning community we co-created in this class is very welcoming and inclusive.

Table 1. Response Distribution of Item 1

Belonging	Course	
	STAT 135	STAT 136 (HIS)
2	1	0
3	1	0
4	0	1
5	3	4
6	6	7
7	7	11
Total	18	23

Table 2. Response Distribution of Item 2

Inclusion	Course	
	STAT 135	STAT 136 (HIS)
2	1	0
3	0	0
4	0	0
5	2	3
6	2	6
7	13	14
Total	18	23

Table 1 and Table 2 summarize counts of responses to Item 1 and Item 2, respectively. While distributions in both tables are not statistically significant between two courses, here are several observations worth noting: (1) both courses have one participating student who didn't fill in the End-of-Semester Survey, bringing the sample sizes down to 18 for STAT 135 and 23 for STAT 136 (HIS); (2) there are 2 students (out of 18) in STAT 135 who didn't feel a sense of belonging, compared to no student (out of 23 total) in STAT 136 (HIS) feeling this way - although one in HIS did rate Item 1 "neutral"; (3) there is one out of 18 students in STAT 135 who didn't feel the class is inclusive, compared to zero student (out of 23 total) in STAT 136 (HIS) feeling so, indicating that the new HIS course is indeed "fully inclusive" for all students; and (4) almost all students in either class agreed that the class is inclusive and they felt a sense of belonging. This last observation makes us wonder if the

instructor of a course plays a more critical role than specific pedagogical strategies when it comes to inclusive teaching. After all, education is a heart business, and an instructor who truly care about their students probably can't hide their love and care towards students in the control group simply by implementing no inclusive interventions.

While the results clearly reveal positive impacts of this new intro stats course on student happiness and learning, it is worth noting that both classes in this pilot study were not very big and both were taught by the same instructor. We are planning to investigate how this Happy Intro Stats course works for larger classes and with different instructors, as well as its longer-term impacts, in the near future.

CONCLUSION

As Paleo said over 2,000 years ago, "all learning has an emotional base", and we believe that it is important for modern educators to attend to the crucial association between emotions, well-being, and learning of their students, especially given the increasing stressors students need to face and the worsening mental health status of modern students. As the first pilot research project to study the intersection of statistics education and mental health, and their interactions in college classroom, this paper reveals positive impacts of self-care practices and inclusive pedagogies on undergraduate student learning and overall happiness, and validates the possibility of making a course "fully inclusive" while making all students feel belonged in class. It is our firm belief that the outcomes of this research not only provide statistics educators with effective strategies and inclusive approaches to help promote student sense of belonging and foster student learning of statistics, but also help shed light on how statistics education can take a more proactive role in solving global mental health crisis.

ACKNOWLEDGEMENTS

REFERENCES
Boehnke, K. and Harris, R.E. (2021). How two neuroscientists built a mindfulness class to improve students' well-being. *Nature, 592*, 645-646.

Brown, J.S.L. (2018). Student mental health: some answers and more questions. *Journal of Mental Health, 27*(3), 193-196.

Copeland, W.E., McGinnis, E., Bai, Y., Adams, Z., Nardone, H., Devadanam, V., Rettew, J., and Hudziak, J. J. (2021). Impact of COVID-19 Pandemic on College Student Mental Health and Wellness. *Journal of the American Academy of Child & Adolescent Psychiatry, 60*(1), 134-141.e2.

Deci, E. L., & Ryan, R. M. (2008). Self-determination theory: A macrotheory of human motivation, development, and health. *Canadian psychology/Psychologie canadienne*, *49*(3), 182-185.

Leibowitz, J. B., Lovitt, C. F., & Seager, C. S. (2020). Development and Validation of a Survey to Assess Belonging, Academic Engagement, and Self-Efficacy in STEM RLCs. *Learning Communities: Research & Practice*, *8*(1), 3.

Liao, S.-M. (2023). SCRATCH to R: Toward an Inclusive Pedagogy in Teaching Coding. *Journal of Statistics and Data Science Education, 31*(1), 45-56.

Liao, S.-M., Bunnell, S., and Jaswal S. (2022). A Call for Being Human in Undergraduate Statistics. In S. A. Peters, L. Zapata-Cardona, F. Bonafini, & A. Fan (Eds.). *Proceedings of the 11th International Conference on Teaching Statistics (ICOTS11)*, Rosario, Argentina.

Lin, L.C., Chan, M., Hendrickson, S., and Zuñiga, J. A. (2020). Resiliency and Self-Care Behaviors in Health Professional Schools. *Journal of Holistic Nursing, 38*(4), 373-381.

Merlo, G. (2021). Happiness and Self-Care. *Principles of Medical Professionalism.* Oxford Academic.

Ryan, R. M. & Deci, E. L.(2000). Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. *Contemporary Educational Psychology*, *25*(1), 54-67.

Woolston, C. (2019). PhDs: the tortuous truth. *Nature*, *575*, 403-406.