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MODESTUM

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Students' perception on blending mathematics teaching with kindness

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ABSTRACT

This paper showcases the effectiveness of integrating deliberate acts of kindness (DAKs) into mathematics education at the university level. Kindness was incorporated into engaged labs, mid-class online quizzes, small-group collaboration, and final grade calculations. Instructors also learned students' names, valued their input, and shared personal anecdotes. We analyse both qualitative and quantitative survey responses from 248 first-year students of an introductory calculus class at a large Canadian university. This study explores the interplay among student perceptions of school kindness, active and effective learning, classroom supportiveness, optimism, prosocial and social goals, life satisfaction, and academic self-efficacy. The results show that instructors' caring behaviours were correlated with positive perceptions of instructor kindness. Furthermore, students of empathetic caring instructors had significantly higher school kindness scale scores. The insights from this study motivate educators to incorporate DAKs into their teaching to enhance student well-being. Additionally, these findings can inform future pedagogical studies and foster advancements in pedagogy research.

Keywords: university kindness, deliberate acts of kindness, teacher student relationships, caring, mathematics

INTRODUCTION

Being a college or university student and thriving amidst the pressures of shifting academic and social expectations can be a complex undertaking (Othman et al., 2019; Shillington et al., 2021). The post-secondary experience for many students is characterized by heightened stress, high rates of loneliness, and a feeling of disconnection from the campus community (Brown, 2018; Robotham & Julian, 2006).

Careers in science, technology, engineering, and mathematics (STEM) fields have been growing rapidly in recent years. Mathematics education typically focuses on teaching well-defined concepts and procedures, which are then applied to real-world problems in science and engineering (Boaler, 2015; Fredricks et al., 2018). However, mathematics can be particularly frustrating for students, with difficulties in understanding mathematical concepts often deterring them from pursuing STEM majors (Leyva et al., 2022). Consequently, mathematics often serves as a gatekeeper for students aspiring to enter STEM-related careers (Li et al., 2002).

Research has increasingly shown the beneficial impacts of kindness in educational contexts. Students who perceive kindness in their schools tend to experience an increased sense of school belonging, higher levels of life satisfaction (Binfet et al., 2016; Lee & Huang, 2021), as well as greater academic self-efficacy (ASE) and engagement (Datu & Park, 2019; Binfet et al., 2016). Both acts of kindness towards others and the practice of self-kindness have been shown to result in greater well-being, higher levels of positive emotions, and lower levels of negative affect (Mongrain et al., 2018; Pressman et al., 2015; Shin & Lim, 2019). Perceptions of kindness at school are associated with positive psychological outcomes, including optimism, happiness, life satisfaction, and social goals (Datu & Park, 2019). Despite this, the integration of kindness into teaching practices, particularly in mathematics, remains underexplored.

Incorporating kindness into mathematics teaching requires teachers to decentre from their own perspectives and adopt the student's perspective, especially as students struggle with challenging math problems (Lim & Matsuura, 2023). Duval (2018) offers several suggestions for integrating kindness into college-level math courses, such as learning students' names, valuing their input, and sharing personal anecdotes to establish rapport. Reaching out to struggling students and showing flexibility are also key recommendations.

Despite the research on kindness conducted thus far, no studies that we know of have investigated kind approaches to mathematics teaching on a large scale (greater than 150 enrolled students) at the university level. To address this gap, this paper reflects on an ongoing effort to improve undergraduate teaching experiences in large introductory mathematics courses at the

University of Guelph through deliberate acts of kindness (DAKs). The objective of this study was to measure the impact of DAKs on students' perceptions of themselves, their peers, and their campus. As a case study for this work, we implemented DAKs into five sections of "MATH*1080: Elements of Calculus I", the largest first-year calculus class at the University of Guelph. The DAKs incorporated in our study include increased flexibility of assignment deadlines, allocating part of the grading scheme to the student's best performances on interactive class activities like *Top Hat* clickers, having two grading schemes for course grades, awarding marks for participation in engaged labs, allowing small-group collaboration in class, and providing open access to preparation materials. Additionally, instructors in this study attempted to incorporate the deliberate kind behaviors detailed by Duval (2018).

This paper begins by clarifying how kindness can be defined, and how it can be blended into teaching practices. We present the details of a questionnaire which uses the school kindness scale (SKS) of (Binfet et al., 2016) to assess students' perceptions of kindness in the school and classroom. We then complete a quantitative analysis of questionnaire responses from "elements of calculus I" to explore undergraduate students' perceptions and experiences of integrating kindness into mathematics teaching.

This work aims to contribute to the limited body of knowledge concerning how university students understand and perceive kindness, particularly in the context of a large class. Furthermore, the goal is to make practical suggestions for mathematics instructors and guide researchers who wish to pursue further studies on this topic.

LITERATURE REVIEW

We begin with a literature review to survey what has already been established about the benefits of incorporating kindness in mathematics education.

Kindness

Kindness positively impacts the well-being of both the actor and the receiver. Kindness, as a pro-social behavior, is recognized as pivotal to social-emotional learning (Kaplan et al., 2016). Social-emotional skills encompass relationship building, emotional regulation, and goal setting (Xu et al., 2023).

Schools increasingly emphasize social-emotional learning due to its positive impact on academic achievement, mental health, and social outcomes (Taylor et al., 2017). Binfet et al. (2022) conducted a study exploring the definition and examples of kindness provided by Canadian university students (n = 93). Participants identified helping others, giving, demonstrating appreciation, and communicating as acts of kindness. These findings align with a 2017 study by Binfet and Passmore (2017), where educators (n = 257) identified caring, respect, help, and encouragement as kind acts. The parallels between these studies indicate similar conceptions of kindness among students and educators.

Levenberg (2023) builds on Binfet et al.'s (2022) research by examining post-secondary education students' (n = 65) perceptions of kindness in online learning. Students identified kindness as professor availability, accessibility, and flexibility, all of which exemplify traits of caring, help, respect, and encouragement.

Kindness interventions, as indicated by Curry et al.'s (2018) meta-analysis, have a mild to moderate effect on well-being, comparable to other positive psychological interventions like mindfulness and gratitude. Acts of kindness not only benefit the receiver and the actor's well-being but also enhance pro-social effort and peer acceptance (Layous et al., 2012, 2017).

Shillington et al. (2021) found that Canadian university students reported increased stress, declining mental health, and heightened anxiety levels. Positive psychological interventions, such as kindness interventions, offer students tools to manage their mental health and well-being. Random acts of kindness projects are shown to increase reported positive emotions, reduce stress, and enhance class enjoyment among university students (Datu et al., 2022; Paviglianiti & Irwin, 2017; Pressman et al., 2015).

Trew and Alden (2015) examine the relationship between DAKs and social avoidance goals in university students with social anxiety (n = 146). Individuals were assigned to either engage in acts of kindness or were exposed to hypothetical scenarios that may trigger social anxiety. The acts of kindness treatment group had the largest decrease in avoidance goals after the 4-week study period.

School Kindness

Binfet et al. (2016) initially conceptualized school kindness as a metric of school climate, encompassing kind actions by all potential actors (e.g., teachers, students, administrative staff). Kaplan et al. (2016) utilized modelling to create a framework for evaluating kindness programs in schools. They identified school climate and student social-emotional skills as key evaluation points.

A literature review by Wang and Degol (2016) underscores the significance of school climate in shaping student-teacher interactions and fostering academic achievement. Emotional safety, characterized by caring and supportive staff, is highlighted as crucial to school climate.

Morgan and Cieminski (2021) surveyed high school students' (n = 4,846) perceptions of school climate dimensions including adult support, adult and student respect, and safety. They found that high school students' perceptions of safety and experience of kindness were significantly correlated with student engagement.

Teacher kindness and positive student-teacher relationships are pivotal to academic engagement and achievement (Kelly & Zhang, 2016; Krane et al., 2017; Yang et al., 2021). Liu et al. (2018) found that the relationship between supportive teacher relationships and academic engagement is moderated by ASE and enjoyment.

Students perceive teachers as key agents of kindness, with most students reporting that their teachers are kind and encourage kindness at school (Szafran & Cwojdzińska, 2021). However, gender differences exist, with females reporting higher levels of school kindness than males (Binfet et al., 2016; Lee & Huang, 2021).

Datu and Park (2019) observed a positive correlation between school kindness and agentic, behavioral, cognitive, and emotional engagement among high school students. Further, a meta-analysis by Wong et al. (2024) finds a correlation between behavioral engagement and academic achievement.

Datu and Lin (2022) found through modelling that school kindness perceived by university students was associated with increased life satisfaction at the end of first and second year after controlling for extraversion, agreeableness, and neuroticism. Lin and Datu (2023) determined that school kindness correlated with reduced COVID-19 anxiety, higher life satisfaction, and psychological well-being among surveyed pre-service teaching students (n = 915).

Binfet et al. (2022) measured Canadian university students' perceptions of school kindness pre- and post-performing five planned acts of kindness. No significant change in perceptions of school kindness post-intervention was found which may be due to participant effort limitations.

In summary, kindness and school kindness positively correlate with psychological outcomes such as well-being and life satisfaction, as well as academic outcomes including engagement and achievement. Given the challenges in mathematics education, integrating kindness into the math classroom is particularly compelling.

Kindness in Math Class

Hackenberg (2005) argues for caring in the mathematics classroom, highlighting its role in student engagement. Hackenberg encourages mathematical caring which she defines as seeing math from the student's point of view. Hackenberg hypothesizes that mathematical caring increases math engagement.

Lim and Matsuura (2023) propose four progressive levels of kindness from conditional to genuine and recommend genuine kindness in teaching. They stress the importance of a conducive math learning environment where students can make mistakes without fear of penalty or shame.

Duggan (2015) suggests approaches to incorporate empathy into math teaching, emphasizing understanding students' feelings about math and encouraging active listening. Buenconsejo et al. (2023) examine perceptions of school kindness among high school students in a cross-national study encompassing the Philippines, Hong Kong, and China (n = 1,692). School kindness was associated with higher math engagement across the countries sampled.

Kelly and Zhang (2016) investigate the relationship between supportive teacher relationships and student engagement among high school students (n = 25,210) in a math and science course context. This study uses two-stage sampled data on student engagement in math and science classes as well as the perceived level of teacher support. Differences in teacher support were associated with differences in cognitive, behavioral, and affective engagement outcomes.

Leon et al. (2017) measure high school teacher quality with pro-social dimensions including acknowledgement of negative feelings of students and encouraging participation. They find that teacher quality is a predictor of high school student behavioral engagement (n = 1,555). They also find classes with higher behavioral engagement have higher math achievement.

Liu et al. extend on the findings of Leon et al. in their 2018 study examining the interplay between ASE, teacher support, and academic engagement of elementary school math class students (n = 896). Teacher support was found to have a significant impact on student engagement in math and this effect is moderated by ASE and enjoyment. In a similar study in 2021, Yang et al. looked at the chain-mediating effect of ASE and behavioral engagement in math classes for elementary students (n = 1,294). Teachers who emotionally supported their students had a direct impact on the math performance of their students, while ASE and math engagement had an intermediary effect.

Umarji et al. (2021) use growth curves to show that math motivation declines through middle school and high school. However, they found that students' perception of teacher caring is correlated with math self-efficacy and caring teachers slow the decline of students' math motivation.

Engaged Mathematics Lab

In prior collaborative work of the first author, students in "MATH*1080: Elements of Calculus I" had weekly 50-minute labs, and three of the weekly labs during the semester were engaged mathematics labs (Mohammad et al., 2023). During the engaged mathematics labs, students formed their own groups of two or three students. Students were assisted to form groups by graduate teaching assistants (TAs) if required (common in first year labs). Students were then given a set of questions to work on as a group, but the lab assignment was submitted individually at the end of the period. TAs then marked individual lab assignments and returned them with feedback to the individual students. Research indicates that engaged mathematics labs are positively received by students, facilitating their effective use of course materials to deepen their understanding of course content (Mohammad et al., 2023).

Top Hat

Top Hat is a web-based student response system that enables instructors to conduct polls, initiate discussions, deliver lecture materials, and monitor attendance (Tophatmonocle Corporation, n. d.). It allows students to engage in these activities using their own devices. According to social constructivist theories, effective learning occurs within a supportive community where students interact positively and learn collaboratively (Lin et al., 2021). Peer discussions have been shown to increase answer accuracy and boost student confidence in their responses (Tullis & Goldstone, 2020).

Table 1. Demographic characteristics of participants

Variable	Category	Frequency	Percentage (%)
Reported sex	Female	193	77.8
	Male	55	22.2
Instructor	A	41	16.5
	B	103	41.5
	C	50	20.2
	D	54	21.8
Age	≤ 18	175	70.6
	19	39	15.7
	≥ 20	34	13.7
Term	Fall	195	78.3
	Winter	54	21.7

Table 2. Grading schemes for elements of "MATH*1080: Elements of Calculus I"

Scheme 1	Percentage (%)	Scheme 2	Percentage (%)
Top Hat questions	5%	*Top Hat* questions	5%
3 lab assignments	15%	3 lab assignments	15%
Midterm test 1	25%	Best midterm test	30%
Midterm test 2	30%	Worst midterm test	15%
Online final exam	25%	Online final exam	35%
Total	100%	Total	100%

The use of interactive technology in classrooms offers several advantages. Instructors can tailor lessons to address specific student needs by identifying areas of weakness more easily (Aljaloud et al., 2019; Vana et al., 2011). Additionally, students build stronger connections with peers, enabling resource sharing and mutual support (Lin et al., 2021). Meta-analysis of clicker-based technologies has demonstrated positive effects on both cognitive and non-cognitive learning outcomes (Hunsu et al., 2016). However, it's important to acknowledge that digital distractions can potentially diminish student engagement during lectures (Pistilli & Cain, 2016; Wang et al., 2022).

Objectives

The aims of this study are the following:

1. To discern the impact of DAKs on students' perceptions of school kindness.
2. To investigate university student perceptions of kindness in the context of a first-year mathematics class (elements of calculus I).
3. To identify trends in student perceptions of kindness in relation to student demographics and instructor characteristics.
4. To further our understanding of the relationship between university student perceptions of school kindness and previously identified self-reported variables.

METHODOLOGY

Sample

Recruitment

A total of 1,604 students across five class sections were enrolled in "MATH*1080: Elements of Calculus I" at the University of Guelph during the school year that the survey was administered (Fall 2023/Winter 2024). Announcements were posted on the course website to all students in each of the course sections describing the study, inviting their participation, and providing a link to the survey. No compensation or incentives were offered to the subjects, nor did the subjects incur any costs in participating.

Demographics

A total of 195 students (13.4%) out of the 1,454 enrolled in the Fall 2023 sections and 54 students (36.0%) out of the 150 enrolled in the first-year calculus course participated in an online end-of-semester survey. The final sample obtained by convenience sampling consisted of 248 first-year students across five sections of the course. The course was taught by 3 different instructors in fall term and by one instructor in the winter term. **Table 1** shows that the majority of students included in the sample are female (77.8%), eighteen years of age or younger (70.6%), and enrolled in the fall semester offering of the course (78.3%).

Research Design

The course "MATH*1080: Elements of Calculus I" teaches the principles of single-variable calculus with an emphasis on mathematical modelling in the biological sciences. All sections are traditional in-person lecture format, and there were three 50-minute classes each week. All sections of the course had the same course format, content, and fillable course notes. Moreover, all sections used the same assessment criteria. Assessments as detailed in **Table 2** included two in-person midterm tests, three in-

person engaged lab assignments (Mohammad et al., 2023), in-class *Top Hat* questions, and an online final exam. Office hours were provided by TAs and the instructors and instructors were available to answer students' questions over email.

Instructors blended mathematics teaching with kindness by intentionally incorporating DAKs into their behavior, lectures, labs, and assessment methods. Most importantly, instructors showed students kindness by learning their names, valuing their input and participation, and sharing personal anecdotes as recommended by Duval (2018).

DAKs were incorporated into lectures by using *Top Hat*. For each *Top Hat* question asked during class, students were awarded two marks: one for participation (regardless of whether the answer was correct) and another for a correct response. Students were encouraged to work though questions independently then collaboratively share ideas before submitting their answers. Finally, if the instructor noted that students performed poorly on a given question, indicating that students did not understand a concept, they would explain the concept again. Then the instructor would offer a second attempt at the question or offer a similar question to allow students to correct their response.

Instructors employed DAKs during the engaged lab assignments. First, students were encouraged and assisted to form their own groups. Second, each student was awarded one 'free' participation point, out of the five possible points available for the lab assignment. This was done to encourage collaboration between students and emphasize learning concepts, rather than solely achieving a high grade. Instructors also incorporated flexibility into the labs by allowing students to complete the lab assignment during other section lab times if they had illness or extenuating circumstances. Lastly, TAs were familiarized with the lab assignment content beforehand so they would be equipped to assist students while they completed it.

Instructors further incorporated DAKs into assessment practices. Assessments, including midterms and the final exam, maintained consistent difficulty and content across sections and terms. Assignments, midterms and the final exam included computational calculations, application-based questions, and multiple-choice questions. The course offered two grading scheme options (**Table 2**), and students' final grades reflected the higher of the two. This grading scheme was applied uniformly across all sections and terms.

Data was collected using an online survey designed by the authors for the study. During the last three weeks of each semester, all students in the five sections under study were invited to complete a survey about their feelings and perceptions of the actions of kindness throughout the course.

Measures

The survey instrument included demographic questions (reported sex, enrolled term, instructor name, age, and grade of the first midterm test) and items addressing perceptions and experiences during their class. The survey consisted of multiple choice, numerical input, and Likert scale style questions. The surveys were brief, requiring less than ten minutes per student to complete.

Students were asked to report their grades of the first midterm test to reflect on their current academic performance. There were two midterms in this course; however, students may not have yet received their second midterm grade as the time of completing the survey, so second midterm grades were excluded from the study. 94.8% (235) of students who completed the survey reported a midterm grade.

School Kindness

The 5-item SKS developed by Binfet et al. (2016) was used to measure school-based kindness by assessing students' perception of the frequency of kindness in their classroom ("Kindness happens regularly in my classroom") and school ("Kindness happens regularly in my school") as well as the extent to which kindness is encouraged ("The adults in my school model kindness"; "My teacher is kind"; "At my school, I am encouraged to be kind"). The scores for each item of the scale are averaged to generate a SKS score and the maximum SKS score is five. The high Cronbach's alpha ($\alpha = 0.88$) for SKS items indicates a high level of internal consistency.

Effective Learning

The questions in the effective learning section were constructed based on concepts explored by Lim and Matsuura (2023) in their 2023 article on blending teaching mathematics with kindness. These Likert-type questions include, "I feel that my teacher selects problems that are appropriate and within the students' zone of proximal development," "I think that my teacher has deep mathematics knowledge for teaching," and "I feel that my teacher sees math problems from my perspective."

Questions in the effective learning section that assess student trust in their instructor include, "I feel that my teacher listens to students' ideas," "I feel that my teacher provides support and encouragement when I need it," and "I feel that my teacher recognizes my frustrations or excitement,". Such questions resemble subscale "a) emotional support from my teacher" from the mathematics classroom connectedness scale (Maloney & Matthews, 2020).

Further, both Lim and Matsuura (2023), and Maloney and Matthews (2020) identify caring profiles (empathetic, blended, and transactional) that instructors have. This survey asks students to identify which caring profile their instructor exhibits. Empathetic caring involves authentic empathy towards students' challenges and prioritizing their well-being, while transactional caring may involve conditional or superficial interactions (Maloney & Matthews, 2020). Blended caring combines traits of both empathetic and transactional caring.

Cronbach's alpha, assessing consistency across responses, yielded a high value of 0.91 for the effective learning questions, suggesting high consistency in students' answers (Barbera et al., 2021).

Self-Reported Variables

In line with foundational research on the SKS (Binfet et al. 2016), the pattern of associations of the SKS were checked against a corpus of theoretically relevant constructs obtained via student self-reports. The constructs and measures used in this survey are the same as used in previous research by Binfet et al. (2016).

Perceived classroom supportiveness

Classroom as a Community measure by Battistich et al. (1997) was adapted in this survey to assess student perceptions of classroom supportiveness. This scale has been previously found to be valid and reliable (Battistich et al., 1997). This study assesses perceptions of classroom supportiveness with a 2-item Likert-type subscale including, "Students in my class help each other learn" and "Students in my class are willing to go out of their way to help someone."

Optimism

This study assessed students' dispositional optimism with the optimism subscale from the resiliency inventory (Noam & Goldstein, 1998; Oberle et al., 2010; Song, 2003). The optimism subscale concerns the respondent's positive perspective on the world and the future. One Likert-type item from this subscale was utilized in this survey ("More good things than bad things will happen to me"). The resiliency inventory has previously shown reliability and validity (Noam & Goldstein, 1998; Oberle et al., 2010; Song, 2003).

Academic self-beliefs

The ASE scale (Roeser et al., 1996) was used to assess students' feelings of how capable they are at completing their mathematics coursework. This six-item scale has been shown to be valid and reliable (Roeser et al., 1996). The subscale used in this survey is comprised of two items, "Even if the schoolwork is hard, I can learn it" and "I can do even the hardest schoolwork if I try."

Subjective happiness

The subjective happiness scale adapted for children (Holder & Klassen, 2010) was used to assess students' happiness. The original measure is composed of four items and has both convergent and discriminant validity (Lyubomirsky & Lepper, 1999). The two questions of the original scale included in this survey are: "In general, I consider myself …" and "Compared to most of my peers, I consider myself …" The response options are numerical, ranging from "1 - not a happy person" to "7 - a very happy person."

Social goal pursuit

Students' prosocial and social responsibility goals were assessed using a subscale of the social goals scale by Wentzel (1993). The social goals scale has been shown to be valid and reliable (Wentzel, 1993; Wentzel et al., 2007). The two items used in this survey were, "How often do you try to share what you've learned with your classmates?" and "How often do you try to do what your teacher asks you to do?"

Life satisfaction

The five item satisfaction with life scale for children (Gadermann et al., 2010), was used to assess global life satisfaction. This study uses just two of the 5 items including, "In most ways, my life is close to the way I want it to be" and "So far, I have gotten the important things I want in life."

Statistical Data Analysis

Data analysis was conducted using SciPy. Stats package in Python as well as the FSA package in R. Descriptive statistics were employed to summarize the data. Significance was determined using a p-value threshold of $< .05$ for all statistical tests.

Differences between categories of demographic variables and instructor caring types were assessed using Mann-Whitney (Hart, 2001) or Kruskal-Wallis tests (Corder & Foreman, 2009), as appropriate. Non-parametric tests were chosen due to the ordinal nature of the data collected. Post hoc analysis was conducted using Dunn's tests (Dinno, 2015) with Holm p-value adjustments. Kruskal-Wallis tests have been previously used on convenience samples in pedagogical research and with university student populations (Cheung et al., 2020; Wong & Wong, 2016, Zhu, 2023). However, it is important to note that the results of these tests only pertain to the sample population and cannot be generalized to the broader study population.

Relationships between survey responses, both within and across survey sections, were analysed using Kendall's tau correlations. Kendall's tau was recommended as a robust non-parametric correlation coefficient for ordinal data such as Likert-type questions (Cliff, 1996). According to Schober et al. (2018), a Kendall's tau greater than 0.49 is considered strong, and greater than 0.71 is considered very strong.

Ethical Considerations

This study was conducted in the researchers' own classrooms. The study was approved by the research ethics board prior to the distribution of the survey. The survey was anonymous, with no names or identification used. All information was kept confidential, and the investigator had access to the information only after all final grades were submitted to the registrar's office. There were no known risks to the students.

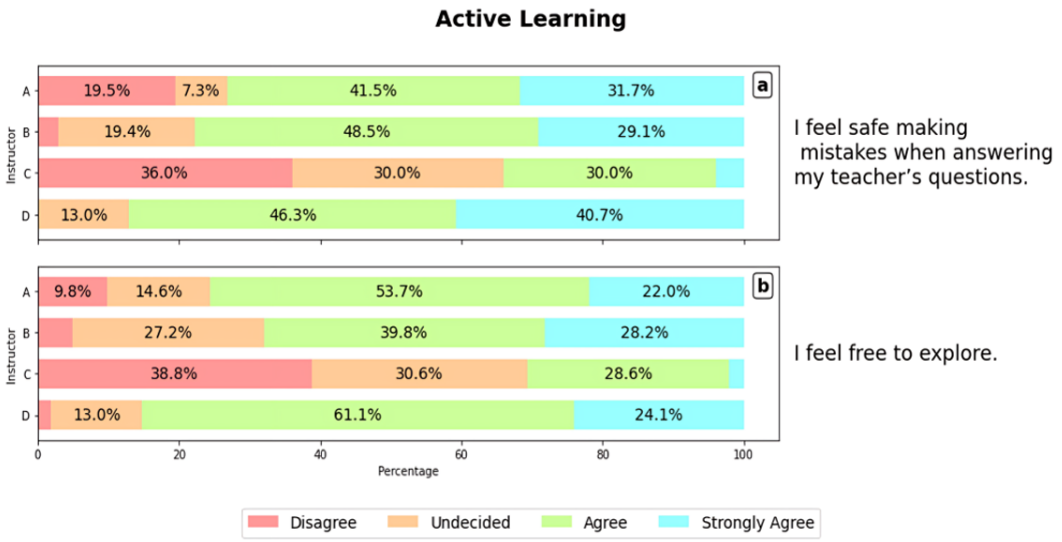

Figure 1. Stacked bar chart with percentages of students' responses to survey questions regarding active learning: Unlabeled levels represent less than 5% of responses (Source: Authors' own elaboration)

RESULTS

End-of-Semester Survey

The end-of-semester survey was divided into the following categories: active learning, effective learning, SKS, and self-reported variables. The self-reported variables section was further subdivided into questions pertaining to perceived classroom supportiveness, optimism, academic self-beliefs, subjective happiness, social goal pursuit, and life satisfaction.

Active learning

Two questions were used to assess if students learn mathematics in an active manner. **Figure 1** shows the distribution of responses to active learning questions divided by which instructor the student had (A, B, C, or D).

Subplot (a) in **Figure 1** shows that most students either agree or strongly agree that they feel safe answering questions in class for instructors A, B, and D. However, for instructor C, most students either disagree or are undecided. The Kruskal-Wallis test revealed significant differences between students' feelings of safety when making mistakes depending on the instructor, H (3) = 47.43, $p < .001$. Dunn's test indicated significant differences between instructors A, B, and D compared to instructor C ($p < .001$).

Responses to subplot (b) in **Figure 1** are like subplot (a) in **Figure 1**, with most students responding positively, except for those with instructor C, who responded negatively. The Kruskal-Wallis test showed significant differences between instructors, H (3) = 43.46, $p < .001$, with Dunn's test revealing significant differences between instructors A and D compared to instructor C ($p < .001$).

There was no evidence of a significant difference between students' comfort in making mistakes when answering questions by reported sex, age or midterm results. Similarly, there was no significant differences between reported sex, age, and midterm results with students' sense of freedom to explore. There was also strong evidence of a correlation between students feeling safe making mistakes in their classroom (item 1) and feeling safe to explore (item 2), r_τ (246) = .59, $p < .001$.

Effective learning

Eight questions assessed student perceptions of effective learning. The subplots in **Figure 2** detail responses to survey questions on active learning divided by instructor, with a focus on students' perceptions of instructor's caring behaviors. There was no evidence of significant differences for reported sex, age, or midterm grade and any of the questions in the effective learning section of the survey.

Subplots (a), (b), (d), and (e) reveal that students under instructors A, B, or D mostly agree that their instructors listen to their ideas, share mathematics perspectives, validate emotions, and provide encouraging support. Conversely, students under instructor C predominantly disagree with these attributes. Kruskal-Wallis tests show evidence of a difference in perceptions between instructors for all questions, H (3) = 124.36, 83.05, 47.42, 78.12, 93.22, $p < .001$. Subplot d indicates varied perceptions of feeling validated by instructors when students struggle with a concept across instructors A, B, and D. Dunn's test show's significant differences in perceptions between Instructors A, B, and D with instructor C ($p < .001$).

Kendall's tau correlations reveal strong correlations between questions in this section of the survey. There is evidence of a strong correlation between instructors and students sharing mathematics perspectives (item 4) and recognizing positive and negative emotions (item 6), r_τ (246) = .65, $p < .001$ as well as providing emotional support (item 7), r_τ (246) = .61, $p < .001$. Moderate correlations exist between perceptions of instructor competency (item 8 and item 9) and instructor caring (item 5 and item 6, respectively), r_τ(246) = .39, .36, .47, $p < .001$.

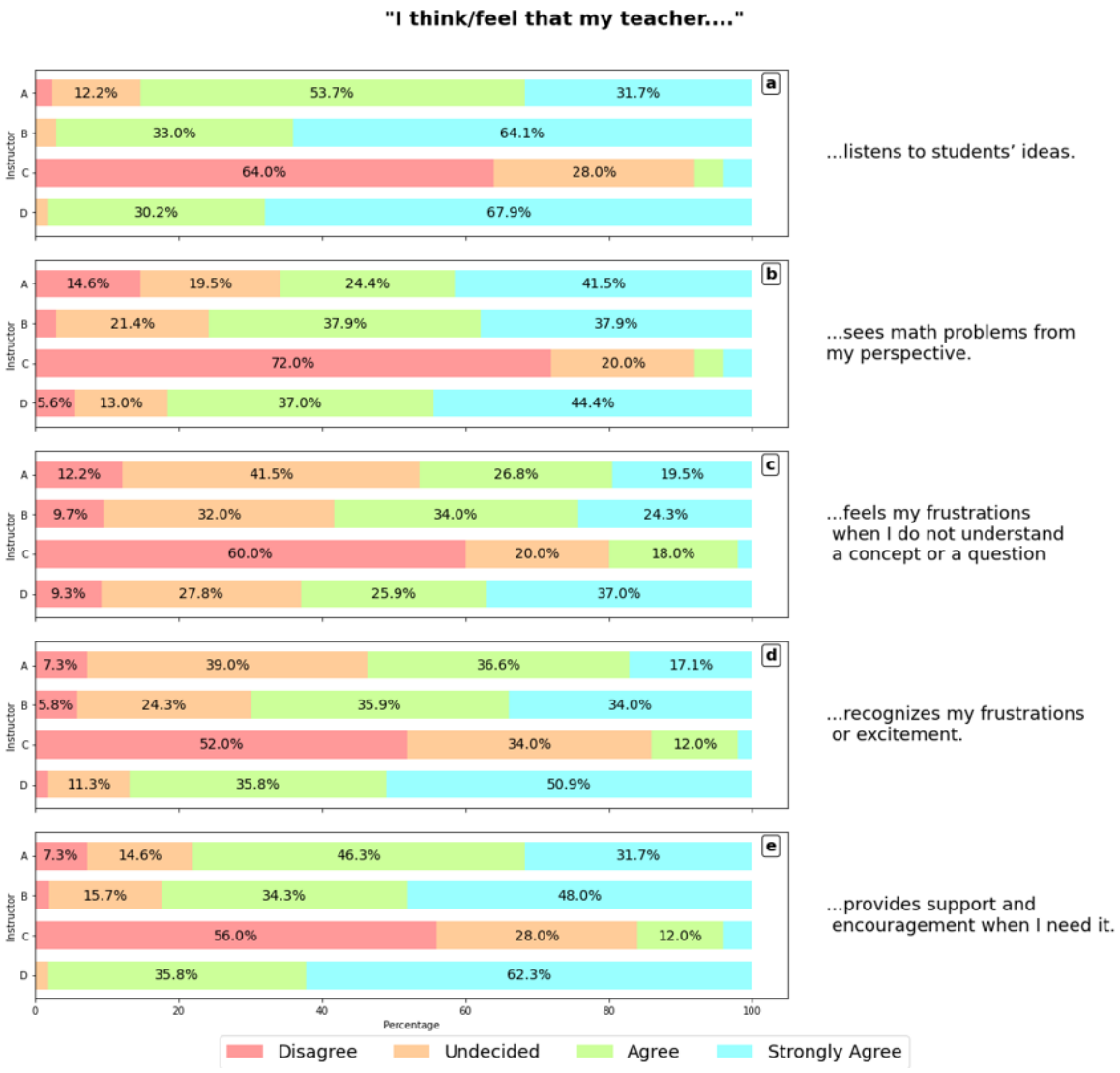

Figure 2. Stacked bar charts with percentages of students' responses to survey questions regarding effective learning: Individual subplots are labeled by lowercase letters. Unlabeled levels represent less than 5% of responses (Source: Authors' own elaboration)

School kindness scale

All SKS items use a five-level Likert scale ranging from strongly disagree to strongly agree. Responses indicating strongly disagree and disagree were combined as there were too few 'strongly disagree' responses to allow for valid statistical analysis. Strongly disagree responses accounted for an average of 1.37% of the total responses to individual SKS items. **Figure 3** shows the distribution of student responses to all items.

Overall, responses are generally positive, with most students either agreeing or strongly agreeing across instructors and items. However, subplot (b) in **Figure 3** shows that with students under instructor C report divided perceptions of kindness occurring in their classroom. Kruskal-Wallis tests reveal evidence of differences between instructors for all SKS items, except for student perceptions of kindness at school, H (3) = 12.79, 60.08, 66.42, 8.99, $p < .001$, $p < .001$, $p < .001$, $p = .029$. There was no evidence of an association between students' perceptions of kindness shown by adults, kindness occurring in the classroom, or kindness occurring at school with reported sex, age, or midterm grade.

The median SKS score for students in this first-year calculus course is 4.0 (0.66 standard deviation) out of a maximum possible score of 5 (Binfet et al., 2016). The skew of the responses is -1.35, indicating that most students report positive perceptions of school kindness.

Kendall's tau correlations reveal a strong correlation between scale items assessing perceptions of kindness at school (item 12) and within the classroom (item 11), r_τ (246) = .54, $p < .001$. Student perceptions of instructor kindness (item 13) are strongly correlated with perceptions of kindness occurring in both the school (item 12) and the classroom (item 11), r_τ (246) = .52 and r_τ (246) = .52, respectively, $p < .001$. Additionally, students' perceptions of instructor kindness (item 13) are strongly associated with their feelings that they are encouraged to be kind (item 14), r_τ (246) = .52, $p < .001$.

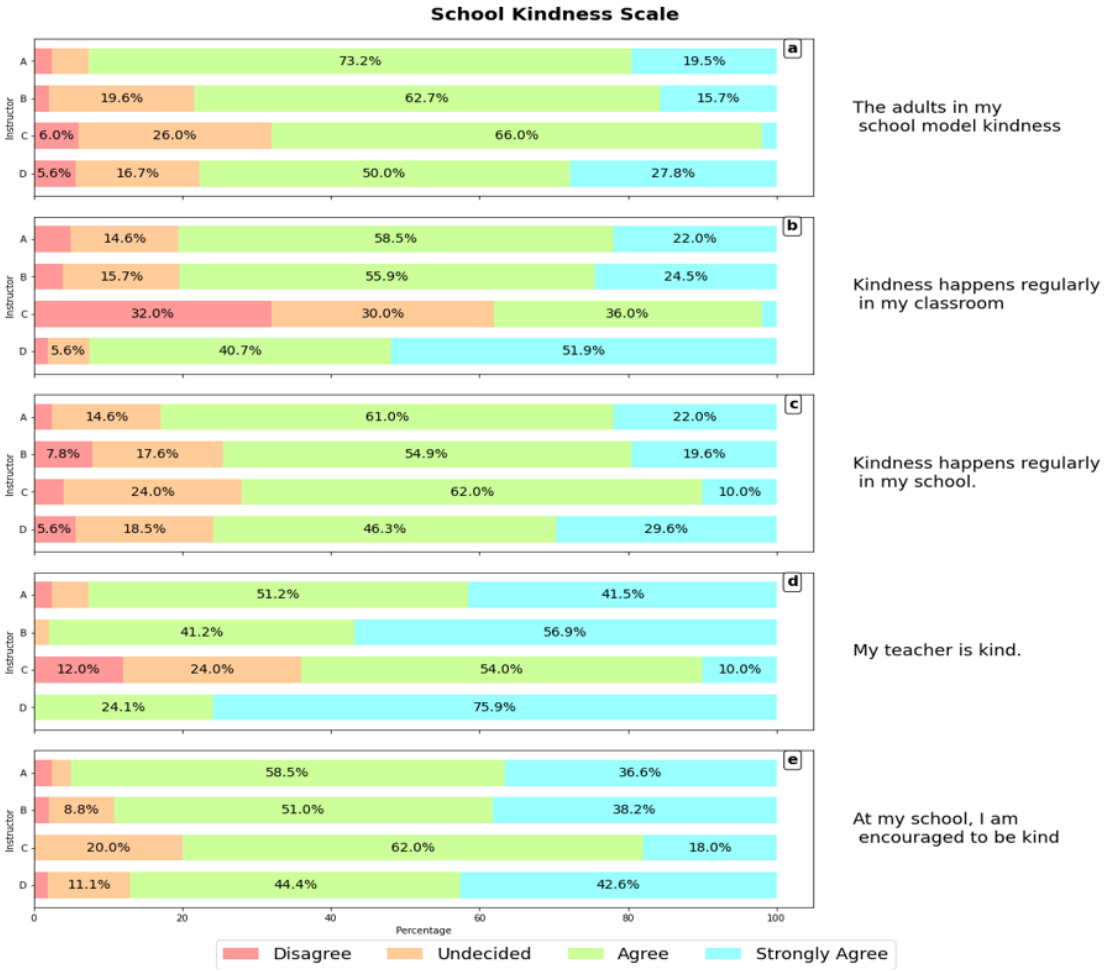

Figure 3. Stacked bar chart with percentages of students' responses to items of the SKS: Individual subplots labeled with lowercase letters. Unlabeled levels represent less than 5% of responses (Source: Authors' own elaboration)

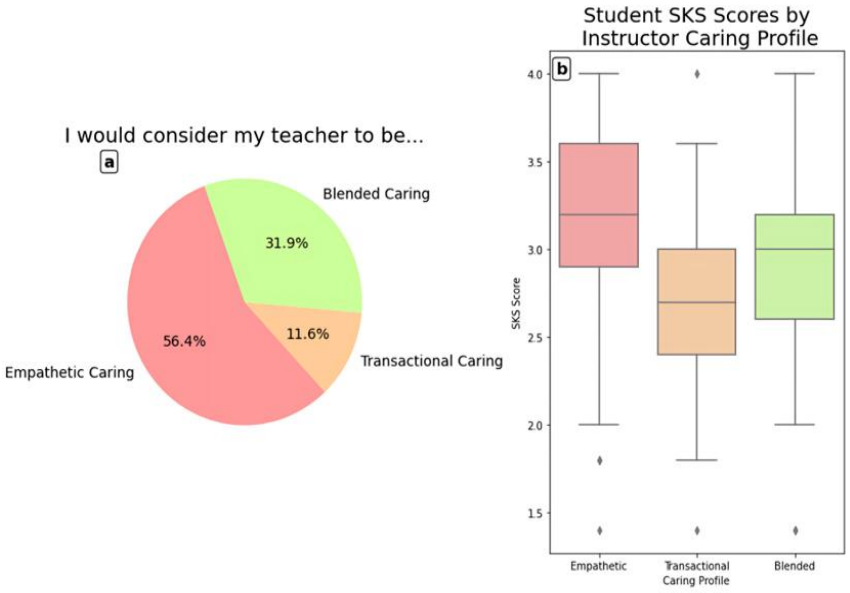

Figure 4. (a) Pie chart with percentages of students' responses to survey questions asking student to identify the caring profile of their instructor & (b) Box plot showing distribution of SKS scores by instructor caring profile (Source: Authors' own elaboration)

Caring profiles and the school kindness scale

Figure 4 displays how students perceive the caring profile their instructor shows. Subplot (a) in **Figure 4** suggests that most students surveyed identify their instructor as empathetic caring. Further, instructors who show empathetic caring as identified by their students also have higher average perceptions of school kindness, as shown in subplot (b) in **Figure 4**.

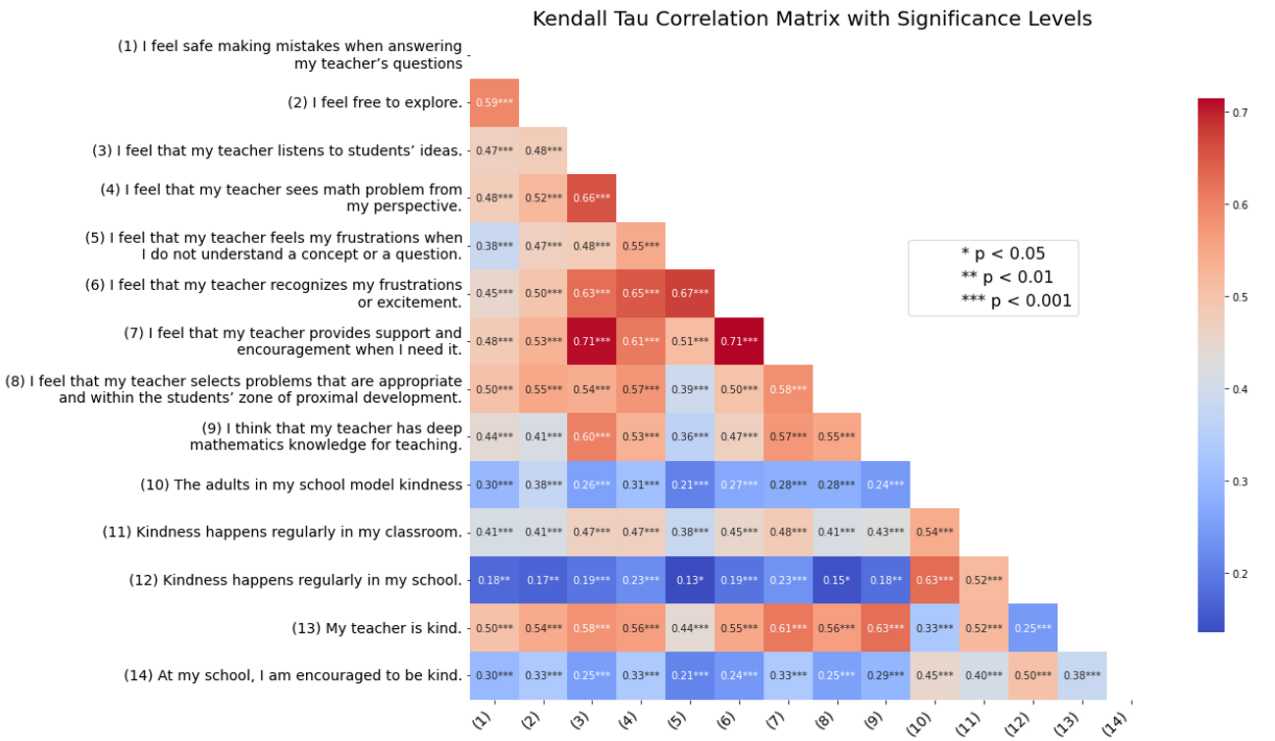

Figure 5. Correlation matrix for selected survey questions: Colors are relative to other values in the matrix & The p-values are denoted in asterisks according to the legend (Source: Authors' own elaboration)

Kruskal-Wallis tests were carried out to assess the hypothesis that there is a difference between student identified instructor caring profile and student perceptions of school kindness. There was strong evidence of a difference between caring profiles for students' perceptions of kindness occurring in their classroom, H (2) = 20.69, $p < .001$. There was also very strong evidence of differences in student perceptions of instructor kindness by caring for the profile, H (2) = 36.23, $p < .001$. Post-hoc analysis with Dunn's test for both questions showed strong evidence of differences between empathetic caring with blended ($p = 0.0088$ and $p = 0.040$, respectively) and transactional caring ($p < .001$ for both classroom and instructor kindness). Lastly, there was some evidence of a difference between caring profiles and students feeling encouraged to be kind, H (2) = 6.16, $p = .046$. Overall there was also strong evidence of a difference between caring profiles and median SKS score H (2) = 18.51, $p < .001$, with Dunn's tests indicating significant differences between empathetic caring and both transactional and blended caring ($p < .001$ and $p = .014$, respectively).

Relationships between perceptions of kindness and effective and active learning

Figure 5 shows Kendall's tau correlations between questions across the active learning, effective learning and SKS sections of the survey. Correlations between all questions were calculated and the sections highlighted exhibit the strongest correlations.

There are very strong correlations between students' perceptions of their instructor providing emotional support (Item 7) and their feelings of being listened to and emotionally validated, as indicated by questions (item 3) and (item 6), r_τ (246) = .71, .71, $p < .001$. Similarly, there are strong correlations between students' perceptions of instructor kindness (item 13) and their feelings of instructor caring as indicated by Items 3 through 7, r_τ (246) = .58, .56, .55, .61, $p < .001$.

There is also a strong correlation between perceptions of instructor kindness (item 13) and instructor competence (item 8 and item 9, respectively), r_τ (246) = .56, .63, $p < .001$. Perceptions of school kindness are weakly correlated with questions regarding emotional safety, instructor caring, and competence. These qualities are also weakly correlated with perceptions of adults modelling kindness and moderately correlated with students' feelings of being encouraged to be kind.

Self-reported variables

Figure 6 shows the distribution of responses for Likert-type questions assessing several self-reported variables.

Item 1 and item 2 in **Figure 6** assess students' perceived classroom supportiveness. Most students either agree or strongly agree that students help each other learn. There is no evidence of significant differences in responses to classroom supportiveness questions across reported sex, midterm grade, or instructor.

Kruskal-Wallis tests revealed differences in perceptions of student helpfulness by student age,

H (2) = 7.60, $p = 0.022$. There were also significant differences in self-reported student optimism (**Figure 6**, item 3) by instructor, H (3) = 17.60, $p < .001$, and instructor caring profile, H (2) = 13.06, $p = .001$.

Items 4 and 5 assess students' academic self-beliefs. Most students across instructors either agree or strongly agree that they are capable of mastering difficult content. There was no evidence of differences in self-reported ASE beliefs by neither reported sex nor age.

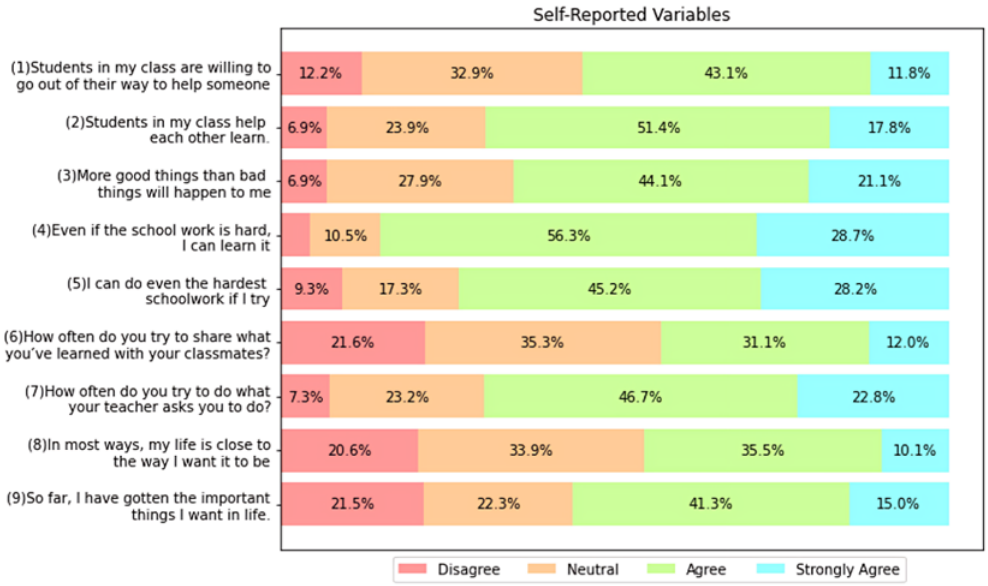

Figure 6. Stacked bar chart with percentages of students' responses to survey questions regarding various self-reported variables: Unlabeled levels represent less than 5% of responses (Source: Authors' own elaboration)

Kruskal-Wallis tests indicate evidence of a difference in student responses between instructors for ASE questions (**Figure 6**, item 4 and item 5), H (3) = 15.70, 11.55, $p < .001$. There is also evidence of differences in students feeling capable of learning difficult content by instructor caring profile, H (2) = 9.25, $p = .0098$, and student midterm performance, H (4) = 13.14, $p = .011$.

Item 6 and item 7 of **Figure 6** assess student social goal pursuit. There is no evidence of a difference in responses across students under different instructors or by reported sex. Responses to the statement "How often do you try to share what you've learned with your classmates?" are varied, with approximately a third of students indicating they sometimes share their learnings. However, most students report that they often or always attempt to do what their instructor asks.

Kruskal-Wallis tests show that there is evidence of a difference in how often students share their learnings by both age, H (2) = 6.83, $p = .033$, and midterm performance, H (4) = 10.24, $p = .037$. Student reports of how often they do as their instructor asks have evidence of significant differences by instructor caring type, H (2) = 7.18, $p = .028$, and midterm performance, H (4) = 16.31, $p = .002$.

There is no evidence to suggest that student midterm performance differs across instructors. Lastly, there was some evidence to suggest a difference in student reported life satisfaction (**Figure 6**, item 8) by instructor caring profile, H (2) = 6.02, $p = 0.043$.

DISCUSSION

This study aimed to examine university students' perceptions of school kindness in a large mathematics classroom context. The results suggest three key findings. Firstly, despite each section having the same course design, students' perceptions of behavioral engagement, classroom kindness, and academic self-belief differ by instructor. Second, caring behaviors exhibited by instructors are associated with student perceptions of instructor kindness (see **Figure 5**). Thirdly, empathetic caring by instructors is associated with higher perceptions of school kindness compared to transactional and blended care behaviors (see **Figure 4**).

The personality of the instructor appears to be related to students' sense of comfort in making mistakes while participating in classroom discussions (see subplot [a] in **Figure 1**). This association is important as Kiseleva (2016) observed that 23% of first-year students in a longitudinal study of student fear and anxieties reported anxiety regarding interactions with course instructors. By alleviating student anxieties and promoting a sense of safety, instructors support student engagement and exploration in the learning process (Hsu & Goldsmith, 2021).

Which instructor the student had was significantly associated with differences in student perceptions of active and effective learning (see **Figure 1** and **Figure 2**, respectively), school kindness (see **Figure 3**), and ASE (see **Figure 6**, item 4 and item 5). Prior studies have observed that instructor characteristics significantly impact student outcomes (Leon & Núñez, 2017; Lewis et al., 2012; Wang & Degol, 2016; Wong et al., 2024; You et al., 2021).

Students of different instructors also report different feelings of being able to tackle difficult schoolwork, and previous literature suggests that students feel valued, respected, engaged, and capable of tackling new concepts in an emotionally safe learning environment (Holtcamp et al., 2023). Our study found that students also perceive the extent of kindness occurring in their classroom differently by instructor (see subplot [b] in **Figure 3**), and supportive teacher-student relationships have been previously related to student emotional engagement (Kelly & Zhang, 2016; Morgan & Cieminski, 2021; Wang & Degol, 2016).

This study reveals no evidence of a difference in midterm performance across students of different instructors. However, there was evidence of an association between midterm performance and both student perceptions of content achievability, ASE, and social goal pursuit. Numerous previous studies have found that mathematical self-efficacy strongly correlates with academic achievement (Honicke & Broadbent, 2016; Turgut, 2013; Wong et al., 2024; You et al., 2021).

The lack of association between perceptions of active and effective learning with reported sex found in this study is consistent with research by Cooper et al. (2020), which found no difference in STEM education participation across reported sexes among individuals aged sixteen and older. The absence of consistent differences by age is also supported by previous research showing no relation between age and active learning in university math classes (Bahr et al., 2022).

The results of this study indicate that sharing mathematics perspectives is correlated with student perceptions of emotional validation and support from their instructor. Viewing mathematics problems from the perspective of the student who may not yet have a structured approach to mathematical reasoning has been previously hypothesized to benefit teaching quality (Philipp et al., 2021).

Caring acts have been previously identified as methods that instructors can use to show students kindness (Binfet & Passmore, 2019; Levenberg, 2023; Krane et al., 2017). This study found a strong correlation between student perceptions of instructor caring acts and instructor kindness (see **Figure 5**, item 13 vs. items 3-item7). Additionally, student perceptions of instructor kindness were found to be associated with perceptions of school and classroom kindness (see **Figure 5**, items 11, 12, and 13). Furthermore, instructor kindness was correlated with students feeling encouraged to be kind (see **Figure 5**, item 13 and item 14). These findings support the idea that undergraduate students who witness and engage in kind behaviors in classrooms are likely motivated to exhibit kindness to others (Datu & Lin, 2021). Moreover, helpful behaviors from both university students and instructors have previously been identified as key factors affecting students' perceptions of school kindness (Binfet et al., 2022; Cheng & Adekola, 2022).

This study found no association between perceptions of kindness and reported sex or age. Such findings differ from previous research, which showed that perceptions of school kindness decrease with age (Binfet et al., 2016; Datu & Lin, 2021) and that females perceive higher levels of school kindness than males (Binfet et al., 2016; Lee & Huang, 2021). However, it is challenging to determine the cause of this decrease in isolation.

Students who identified their instructor as showing empathetic caring had more positive perceptions of school kindness on average (see subplot [b] in **Figure 4**). Furthermore, there were significant differences between SKS scores and empathetic caring versus transactional and blended caring types. Previous research has found that instructor kindness is important to university students; although instructor kindness can be perceived as conditional (Cheng & Adekola, 2022). Maloney and Matthews (2020) found that students of empathetic caring instructors were more likely to feel more emotionally supported, more connected to their classmates, and that their efforts in the class are recognized more than students of instructors with other care profiles.

CONCLUSION

This paper examined the relationship between DAKs and student perceptions of school kindness. Behavioral DAKs, such as emotional validation, active listening, and perspective sharing, positively influenced students' perceptions of instructor kindness, particularly among those with empathetic caring profiles. The integration of engaged mathematics labs and mid-class *Top Hat* quizzes in the course design aimed to enhance engagement and foster active learning. Students' perceptions of active and engaged learning in "MATH*1080: Elements of Calculus I" were largely positive with variations in student feedback attributed to different instructors. Correlations were observed among student perceptions of school, classroom, and instructor kindness. Our results also highlighted the association between empathetic caring instructor profiles and student perceptions of school kindness. Additionally, we detailed how DAKs can be incorporated into instructor conduct and course design. Notably, this study addresses existing gaps in school kindness literature concerning university populations and mathematics contexts.

Limitations

While this study provides valuable insights into the importance of emotional safety and kindness in the large mathematics classroom, several limitations should be acknowledged.

First, it is important to note that this was an observational study, where the students responded voluntarily to the survey questions, instead of a randomized experiment. This limitation implies that while there is an association between instructors' caring behaviors and students' perceptions of kindness, we cannot definitively conclude that one causes the other nor generalize any results to other populations.

Second, this study was conducted using five sections of the same large, first-year undergraduate calculus course during Fall 2023 and Winter 2024 at a large Canadian public university. This course is aimed at students studying biological sciences who typically do not pursue upper-year mathematics courses. Therefore, the results obtained may not be applicable to students in different academic programs.

Third, this study was conducted on students in a first-year calculus course, and results may differ for upper-year courses. The findings of this survey are not applicable to other levels without conducting further studies.

Fourth, the sample size was 248, but the sample was primarily female, which may influence the findings and their applicability to more diverse or predominantly male student populations. This demographic skew suggests that the results may not be consistent with all student groups, and additional research is needed to explore perceptions of school kindness in more balanced samples.

Finally, the study did not include final grades as part of its data, limiting our understanding of how kindness in the math classroom directly impacts overall academic performance. The cross-sectional nature of the study, which captures data at a single

point in time, further restricts our ability to observe changes and developments over time, making it difficult to assess the long-term effects of school kindness.

Recommendations and Future Directions

Based on the limitations identified, several recommendations and future directions are suggested for further research. To better understand the causal relationships regarding school kindness at the university level, future studies should adopt a longitudinal design, to track possible changes in perceptions of school kindness throughout students' university tenure.

Additionally, experimental studies could be conducted to establish causality by manipulating variables such as specific teacher behaviors and measuring subsequent effects on student perceptions of kindness. It is also important to study multiple course disciplines, different enrolment numbers and class sizes, as well as upper-year courses.

Researchers should also consider asking instructors to self-identify characteristics and behaviors that they believe contribute to a kind and caring learning environment. This approach could provide deeper insights into the specific practices and attributes that foster emotional safety and allow development of interventions and training programs for educators.

By addressing these areas, future research can build on the current findings and offer more robust, generalizable conclusions about the role of kindness in higher education.

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Declaration of interest: No conflict of interest is declared by the authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author. Fulfillment of these requests will be subject to the permission of the Research Ethics Boards at University of Guelph.

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