MAA FOCUS

NEWSMAGAZINE OF THE MATHEMATICAL ASSOCIATION OF AMERICA

MAA

Vol. 43, No. 6 | DECEMBER 2023/JANUARY 2024

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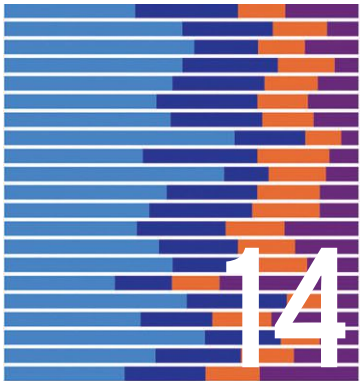

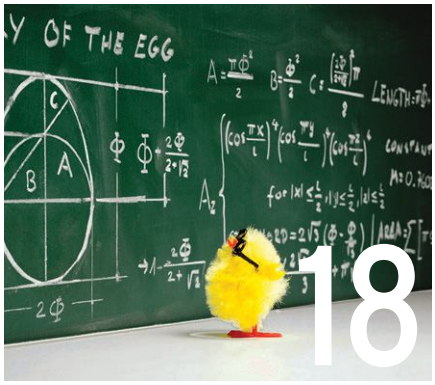

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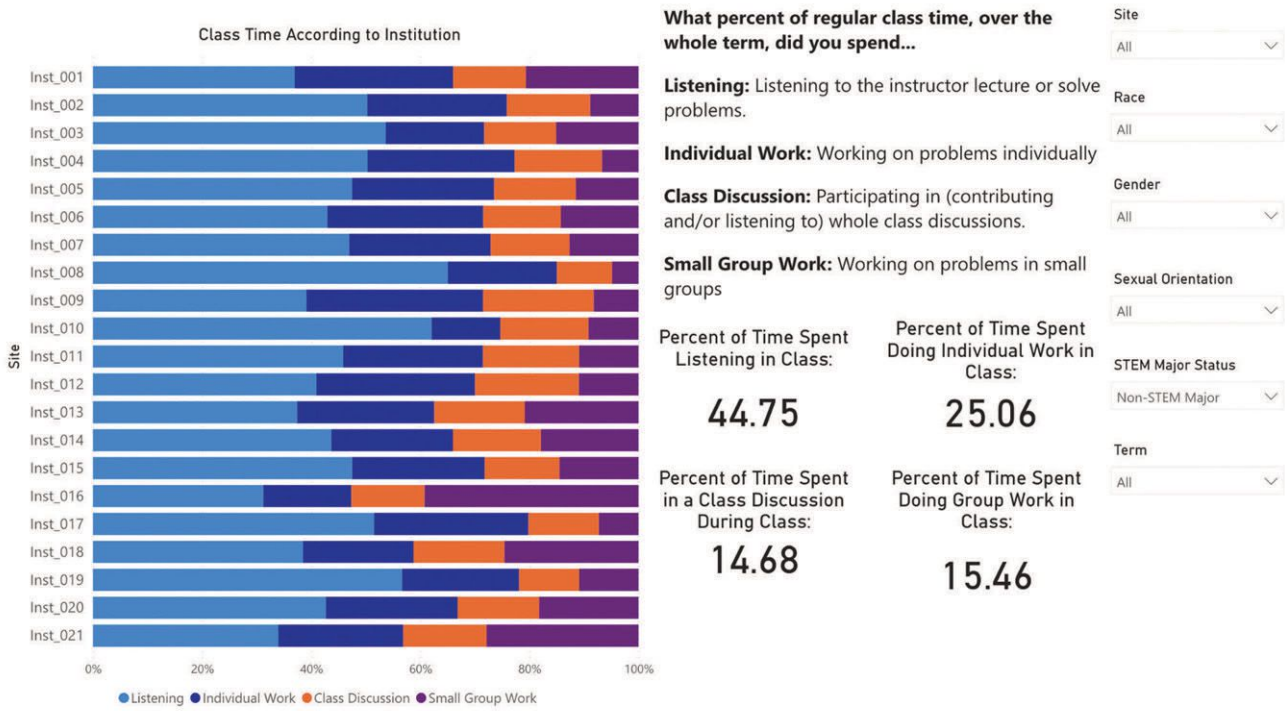


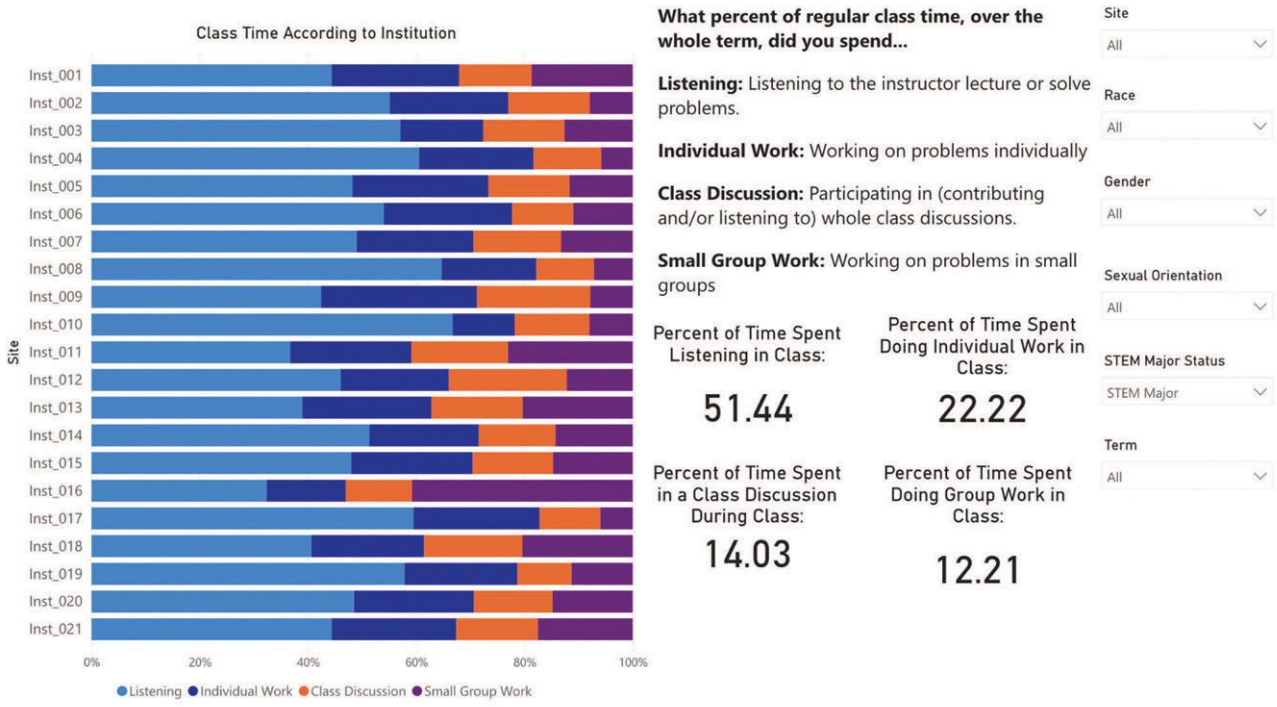
Figure 1. *(two page spread) The difference between non-STEM and STEM declared majors' perceptions on how much class time is spent on listening, individual work, class discussions, and group work.*

Using Interactive Data Dashboards to Address Diversity, Equity, and Inclusion in Introductory Math Programs

Margaret Ann Bolick & Matthew Voigt

In the beginning of the '22–'23 academic year, the research team leading the National Science Foundation-funded project *Achieving Critical Transformation in Undergraduate Programs in Mathematics* (ACT UP Math) examined a corpus of student and instructor self-reported survey data (over 36,000 responses) from two previous math education studies conducted at 21 institutions. The intent of ACT UP Math is to engage three universities (all involved in one of the previous studies) in the formation of Network Improvement Communities (NIC) to address diversity, equity and inclusion (DEI) within lower division mathematics courses at each university. Ultimately, the objective of ACT UP Math is to observe how these NICs engage in equity-based and data-informed decision making to achieve their goals in addressing DEI in math courses. The research team decided to take the previously collected student and instructor data and turn them into two interactive data dashboards, one dashboard dedicated to instructor data collected from the Postsecondary Instructional Practices Survey (PIPS) and the other dedicated to student data collected from the student version of the PIPS (SPIPS) [1].

The dashboards were made of aggregated course data from lower division mathematics courses (College Algebra, Precalculus, Calculus I, and occasionally Calculus 2) at each institution to prevent the ability to pinpoint individual instructors or students in responses. However, the courses were surveyed over multiple semesters with the intent to follow students throughout the math sequence. The interactive dashboards had multiple pages of data with the instructor dashboard utilizing demographics, instructional approaches, class time, and other pedagogical features within the course. The student dashboard featured a wider range of data, starting similarly with demographics, STEM major standing, self-predicted grade,



and beliefs of their mathematics ability and mathematics environments in general. Access to the dashboards is available upon request, but static reports summarizing the data can be accessed at arxiv.org/abs/2111.01795.

The NIC leaders were given space to explore the dashboards during a whole group meeting and provide feedback on changes they would implement in the future. Many members were interested in the ability to filter by specific characteristics of students and instructors including race, gender identity, sexuality, STEM major status, and international status. Additional filters allowed NICs to compare their institution to other institutions and compare by academic terms. The NIC leaders introduced the rest of their communities to the dashboards where they were given space to independently investigate and collaboratively discuss their findings. The diversity of each institution the NICs represent proved to be a factor in what data individuals and groups found interesting.

One NIC was interested in comparing the responses among different racial identities particularly in investigating experiences of Asian, Latinx, Black, and multiracial students. This group further gravitated towards first-generation college students, cisgender women, queer-spectrum students, and STEM-intending students. Collectively, the group had sustained interest in marginalized populations' experiences within their lower division mathematics courses at that institution.

Another NIC was intrigued by STEM vs. non-STEM majors' perceptions of their grades and the amount of time they spent listening in their mathematics course. They assumed that non-STEM majors felt as though lower division mathematics courses required a significant amount of listening and lecture rather than engaging activities, but the dashboards (see Figure 1) proved that theory incorrect, citing that non-STEM majors attributed less listening time to their lower division mathematics course.

Lastly, an additional NIC investigated the difference in enjoyment in mathematics classes from the beginning till the end of the semester. They continued by adding a layer of complexity, diving into the difference in responses between students of different racial identities. They noted that students of marginalized racial identities were reporting more negative experiences by the end of their lower division mathematics courses (see Figure 2 and Figure 3).

Most institutional dashboards focus on the percentage of students who receive a D or an F or withdraw from the course (DFW rate). Students are converted into a statistic that represents the number of As, Bs, Cs or DFWs, which only tells a partial story. Participants in ACT UP Math had the opportunity to explore a more nuanced story by engaging with dashboards that provided insight into students' attitudes towards mathematics, student perception of their mathematics courses and grades, and open responses that captured student voices. The dashboards prompted discussions that other institutional dashboards may not have the data to invoke, nor allow for comparative measures between other institutions. NICs started to think critically about the data collected, asking questions about who is forgotten in the data, how the survey was administered, and how to actively reach students who are missing from the data. The conversation shifted from the age-old question of: "How can we retain more students

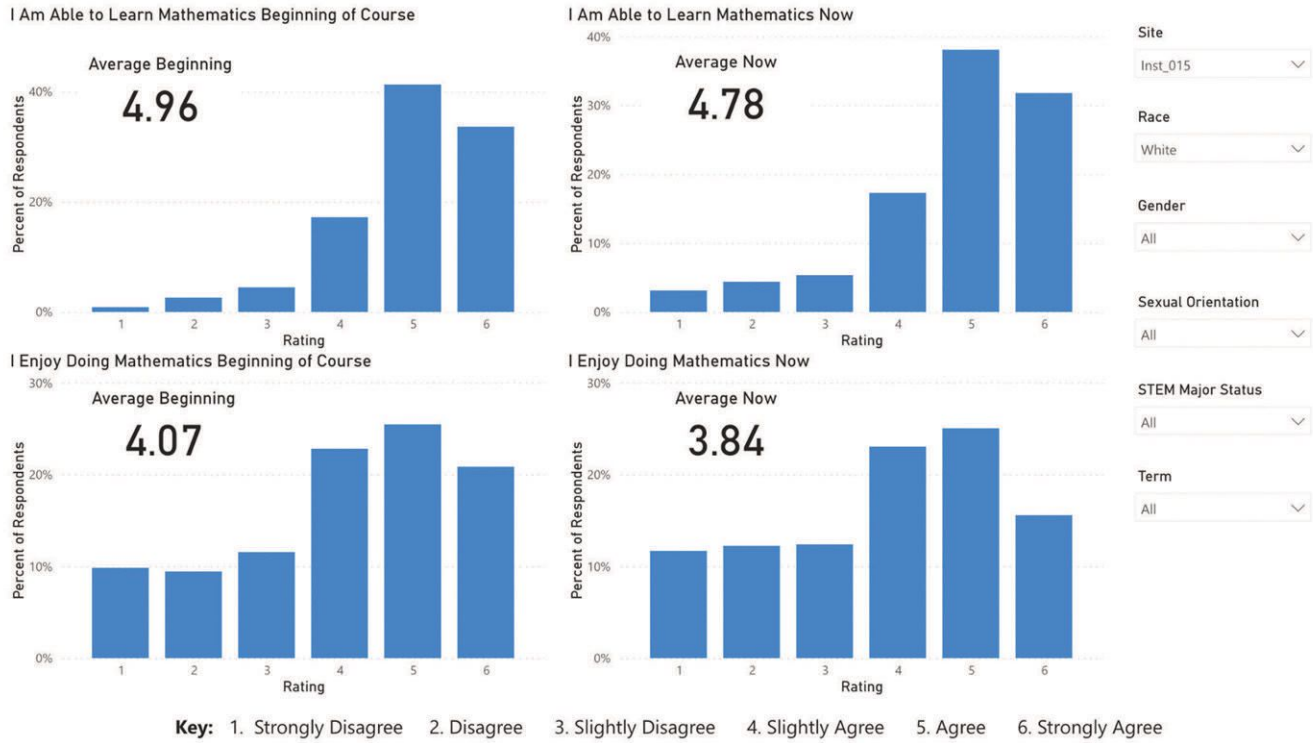


Figure 2. *White students at Inst_015 reported less confidence in their ability to do math and less enjoyment when doing math from the beginning to the end of the semester.*

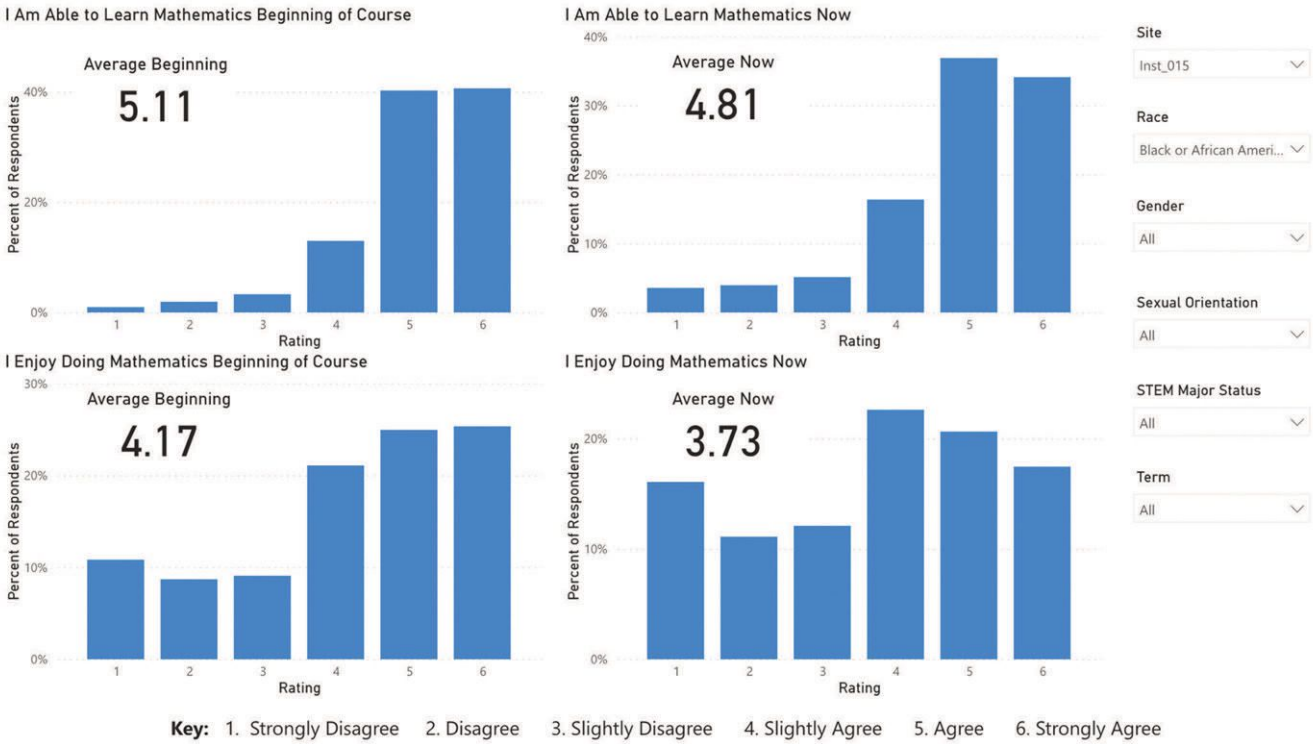


Figure 3. *Black students from Inst_015 similarly reported less confidence and enjoyment in lower division mathematics courses by the end of the semester; however, the drop in average from the beginning of the semester was significantly larger than their white counterparts.*

in lower division math courses?" to "How can we reach the students who are having negative experiences within these mathematics courses and create more positive mathematics relationships among them?"

Now, NICs are fully engaged in making action plans rooted in their observations from exploring the dashboards. One NIC's beliefs about the importance of qualitative data has shifted, causing their action plans to center on two themes gathered through qualitative insights: disrupting the placement system for lower division mathematics courses and creating positive relationships between students and mathematics. Another NIC has decided to restructure to include students, recognizing that students can provide valuable qualitative insight into the mathematics courses at their institution. The third NIC has decided to focus on improving individual instructor pedagogy, given the varied nature of the data. As NICs continue to enact change in their mathematics programs and ACT UP progresses, we are eager to share insights with the mathematics community. Stay tuned!

This material is based upon work supported by the National Science Foundation under Grant 2201486. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

[1] Apkarian, N., Smith, W., Vroom, K., Voigt, M., Gehrtz, J., PtC Project Team, & SEMINAL Project Team. (2019). X-PIPS-M survey suite. Retrieved from: maa.org/sites/default/files/XPIPSM%20Summary%20Document.pdf

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Call for Participation in SIMIODE EXPO 2024

SIMIODE EXPO 2024, 9–11 February 2024, is the fourth international online conference devoted to teaching and learning differential equations through a modeling approach. The conference is in a rich and supportive virtual platform for talks, presentations, poster sessions, fun activities, informal break-out discussions, and on the spot collegial exchanges. The conference is sponsored by SIMIODE – Systemic Initiative for Modeling Investigations and Opportunities with Differential Equations, a non-profit Community of Practice. See all the rich engagements and materials offered in SIMIODE at qubeshub.org/community/groups/simiode.

At qubeshub.org/community/groups/simiode/expo we offer information on SIMIODE EXPO 2024 planning as well as a complete listing of slides and videos of all previous EXPO conference activities.

We offer opportunities for talks by colleagues through our Call for Presentations and Activities as well as abstract submission and registration information. Registration for this rich three-day conference is $25USD/student and $45USD/all others.

Our exciting keynote speakers are Dr. Frank Wattenberg, Emeritus Professor of Mathematics, US Military Academy, West Point NY USA and former NSF Program Officer, and Dr. Doan Winkel, Director Muldoon Center for Entrepreneurship, Boler College of Business, John Carroll University, University Heights OH USA. They will each address issues on the constructive uses of Artificial Intelligence (AI) in the teaching and learning environment and lead break-out discussion sessions.

The program includes sessions on the "how to" of using modeling to introduce and motivate the study of differential equations; sources for data and ideas for modeling; sessions on modeling in calculus and differential equations applied in humanities/social sciences, chemistry/life sciences, and engineering/physics; useful technologies (e.g., WikiModel and InsightMaker); sharing the SCUDEM modeling experiences of students, coaches, and judges for this annual three-student member modeling challenge as well as competition experiences of other student teams and coaches; modeling in undergraduate research; sample classes with rich resources for success; special topics for courses; use of available modeling sources (e.g., SIMIODE, COMAP, and CODEE); panels and discussion on topics of concern to faculty and students; meet the author, Dr. Kurt Bryan, of the SIMIODE low-cost differential equations textbook, *Differential Equations: A Toolbox for Modeling the World*; ideas on the proverbial "How do we do modeling and cover 'required' materials?" as well as other practical issues; and much more.

We plan to have small group gatherings to make new friends and to exchange interests and contact information as well as more extended break-out sessions.

All formal sessions (not informal discussions and break-outs) will be recorded for total conference presentations and later reference as we have done in the past.

We are open to session ideas related to teaching differential equations through modeling and we encourage colleagues to contact Director@simiode.org about your ideas and experiences.

qubeshub.org/community/groups/simiode/expo