

Board 379: SedimentSketch, Teaching Tool for Undergraduate Sedimentology to Provide Equitable and Inclusive Learning for Hispanic Students

Anna Stepanova, Texas A&M University

Dr. Anna Stepanova is a researcher at the Sketch Recognition Lab at Texas A&M University. She holds a Ph.D., Master's and Bachelor's in geology. Anna's research interests are in geosciences, micropaleontology and education.

Dr. Saira Anwar, Texas A&M University

Saira Anwar is an Assistant Professor at the Department of Multidisciplinary Engineering, Texas A and M University, College Station. She received her Ph.D. in Engineering Education from the School of Engineering Education, Purdue University, USA. The Department of Energy, National Science Foundation, and industry sponsors fund her research. Her research potential and the implication of her work are recognized through national and international awards, including the 2023 NSTA/NARST Research Worth Reading award for her publication in the Journal of Research in Science Teaching, 2023 New Faculty Fellow award by IEEE ASEE Frontiers in Education Conference, 2022 Apprentice Faculty Grant award by the ERM Division, ASEE, and 2020 outstanding researcher award by the School of Engineering Education, Purdue University. Dr. Anwar has over 20 years of teaching experience at various national and international universities, including the Texas A and M University - USA, University of Florida - USA, and Forman Christian College University - Pakistan. She also received outstanding teacher awards in 2013 and 2006. Also, she received the "President of Pakistan Merit and Talent Scholarship" for her undergraduate studies.

Juan Carlos Laya, Texas A&M University

Carlos Andres Alvarez Zarikian, Texas A&M University

Nancy Elizabeth Martinez, Texas A&M University

Dr. Tracy Anne Hammond, Texas A&M University

Dr. Hammond is Director of the Texas A&M University Institute for Engineering Education & Innovation and also the chair of the Engineering Education Faculty. She is also Director of the Sketch Recognition Lab and Professor in the Department of Computer Science & Engineering. She is a member of the Center for Population and Aging, the Center for Remote Health Technologies & Systems as well as the Institute for Data Science. Hammond is a PI for over 13 million in funded research, from NSF, DARPA, Google, Microsoft, and others. Hammond holds a Ph.D. in Computer Science and FTO (Finance Technology Option) from the Massachusetts Institute of Technology, and four degrees from Columbia University: an M.S in Anthropology, an M.S. in Computer Science, a B.A. in Mathematics, and a B.S. in Applied Mathematics and Physics. Hammond advised 17 UG theses, 29 MS theses, and 10 Ph.D. dissertations. Hammond is the 2020 recipient of the TEES Faculty Fellows Award and the 2011 recipient of the Charles H. Barclay, Jr. '45 Faculty Fellow Award. Hammond has been featured on the Discovery Channel and other news sources. Hammond is dedicated to diversity and equity, which is reflected in her publications, research, teaching, service, and mentoring. More at <http://srl.tamu.edu> and <http://ieei.tamu.edu>.

SedimentSketch, teaching tool for undergraduate sedimentology to provide equitable and inclusive learning for Hispanic students

Anna Stepanova Saira Anwar Juan C. Laya
Carlos A. Alvarez Zarikian Nancy E. Martinez Tracy Hammond

Abstract

Hispanic student performance indicators are markedly different from students of other ethnicities, with Hispanic students consistently having lower GPAs at graduation. SedimentSketch application will be a visual, personalized, and dual language tool that will combine new curricular materials and sketch recognition algorithms to improve student learning through sketching exercises and automatic, instantaneous feedback. We are currently working on development of SedimentSketch software, and only control group data are being collected.

We hypothesize that SedimentSketch can transform the higher-education geoscience curriculum for Hispanic Serving Institutions (HSI) by enabling geoscience students to interact with the material and receive helpful feedback outside of class and by cultivating a more inclusive learning environment. The goal of this project is to use SedimentSketch application to help close the gap between Hispanic and non-Hispanic students' GPAs, situational interest in geoscience courses, and STEM career trajectories.

Background and motivation

The Hispanic population in the USA has grown significantly over the last 30 years, becoming an important ethnic group in our society. However, this minority group has been marginalized for social and economic reasons. In 2022, Texas A&M University (TAMU) was awarded the status of an HSI (Hispanic serving Institution) serving 25% of the undergraduate student population (Hispanic). The enrollment in undergraduate geosciences aligns with overall university demographics with 25.1% Hispanic undergraduate students in the former College of Geosciences as of Fall 2021. Besides the relatively large enrollment, the Hispanic student performance indicators are markedly different from other ethnicities. Hispanic students have consistently lower GPAs at graduation compared to all other ethnicities. Overall, 6% fewer Hispanic students graduate in 5 years compared to all other ethnicities. Hispanic students represent 25-30% of the First Time In College students in geosciences. In one of the proposed courses for our study, Sedimentology & Stratigraphy, we observed that in 2017-2022, fewer Hispanic students achieved A grades than other ethnicities, with a striking difference: in 2017-2019 (pre-Covid) time, 32% of non-Hispanic students in the course had A as a final grade, while only 20% of Hispanics did. However, during the Covid years 2020-2022, when the instructor added remote and online

activities, the gap between Hispanics and other ethnicities decreased, with 28% of Hispanics earning A grades, while the percentage stayed the same for non-Hispanic students. Previous studies has contradictory and mixed results on the effectiveness of online and remote education for HSI students, and researchers agree that more studies are needed to elucidate the different performance patterns among HSIs [1].

Study Goals

The main research goal of this project is to develop and evaluate the effectiveness of SedimentSketch application and to help close the gap between Hispanic and non-Hispanic students' GPAs, situational interest in geoscience courses, and STEM career trajectories.

1. This project will provide a new educational tool for instructors to teach the basics of sedimentology that will enrich undergraduate geoscience course curricula, and specifically support Hispanic students by providing them with tools for success by improving accessibility, reducing language barrier (providing Spanish language support), and facilitating learning through sketching and visualization.
2. The SedimentSketch application will help close the gap between Hispanic and non-Hispanic students GPA. It was shown, that active learning tools and remote learning can improve grades for Hispanic students [2, 3]. SedimentSketch will support active learning and allow students to practice from home and receive individual feedback and improve their situational interest in geoscience as they progress in learning sedimentology.
3. The project will improve career trajectories for Hispanic students by improving their learning, GPA, and providing an innovative tool for hands-on learning activities.

Methods

Our team will assess the effectiveness of SedimentSketch in several courses in the College of Arts & Sciences (CoAS) at Texas A&M University. Classroom testing will allow us to evaluate the effectiveness of the novel SedimentSketch tool for students' learning, specifically how it can benefit students at HSIs. We will use quantitative and qualitative methods to demonstrate the effectiveness of SedimentSketch on students' learning, benefits to students, and the HSI as a whole, students career trajectories, and situational interest. For this purpose we will collect data using pre and post surveys on students' demographics, situational interest, career trajectories, and technology acceptance. Additionally, we designed a conceptual assessment and are implementing it at multiple time points within a semester. We will embed students' learning analytics measures within the SedimentSketch application. For data collection, we follow the approved study protocol IRB2023-1037M, with an expiration date of 11/28/2026.

For quantitative data analysis, we will use standard statistical tests (using mean comparisons, chi square, and regression, etc.) abiding by the standards for statistical significance. For qualitative data, we will use axial coding and thematic analysis.

SedimentSketch software

SedimentSketch will be a web-based software application that will allow instructors to create customized virtual lab classes with a personalized experience and automated feedback to students. No coding experience is needed for instructors to tailor these classes to use with their teaching plan. The active learning software SedimentSketch will facilitate student mastery of sediment identification and description; and provide a unique interactive environment for students to practice and improve their sedimentology skills while receiving individual feedback as they learn about different types of sediments/rocks.

Some SedimentSketch features will address the traditional disadvantages and underrepresentation of Hispanic students in STEM. These features include: 1) Ability to switch to Spanish language, thus being able to cater to varying learning styles. The basic learning styles are visual and auditory. Visual learners prefer information that includes pictures, diagrams, and plots, while auditory learners prefer spoken words [4]. Most people of college age and older are visual, while most college teaching is verbal. This mismatch leads to poor student performance. Although visual learning is important for all students, for non-English speakers it becomes even more critical, as processing foreign language is more complicated. Educational researchers suggest that the way to accommodate all students is add visual materials, such as pictures, diagrams, and sketches [4]. Other SedimentSketch features will include: 2) Automatic feedback and ability to study remotely; and 3) Sketching. These features will help destigmatize “help-seeking” behaviors, as students will be able to practice on their own, at their own pace, and catch up on any classes they may have missed. It will help to overcome any possible lack of pre-college preparation and help students adjust to the demands of the college level classes. Sketching will help to visualize and understand sedimentology concepts. There is evidence that sketching might improve learning, and that students perceive sketching as helpful for their understanding [5].

Preliminary Results

The first year of the project is devoted to development of SedimentSketch software and educational materials, as well as control group data collection.

We are currently developing educational materials that follow the sedimentology course curriculum. Some additional elements in SedimentSketch are 3D sedimentary rock models, interactive games, and exercises, see Fig. 1.

Preliminary Control Group data collection results in undergraduate geoscience courses teaching sedimentology at Texas A&M in Spring 2024 showed that students are often unclear on how to explain basic sedimentology terms and simple routine steps to identify a sedimentary rock. Students were lacking understanding of the applications of sedimentology for climate and sea-level change reconstruction. In contrast, they performed much better when providing examples of industry applications. These results could imply that students understand the end application but lack conceptual knowledge, and knowledge on how to perform sedimentological activities.

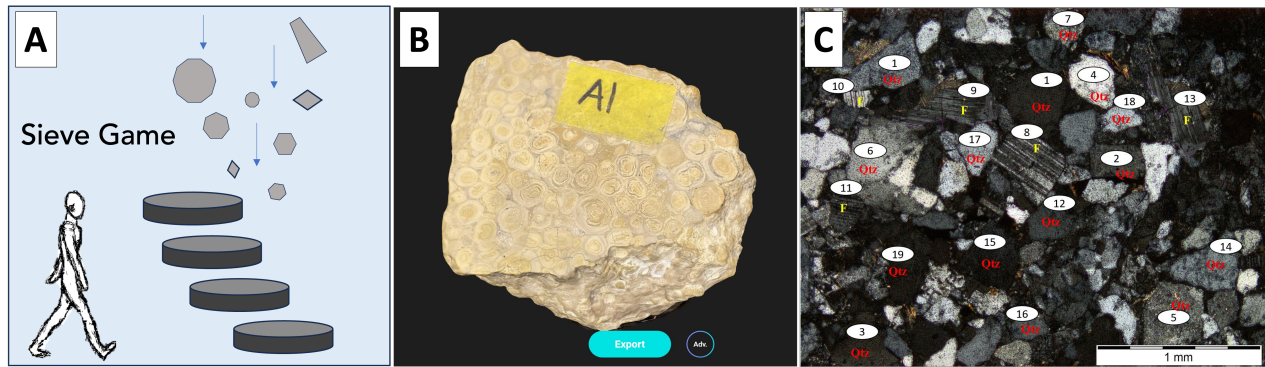


Figure 1: Examples of SedimentSketch Modules: A. Sieve game to learn about grain size feature. B. 3D Sedimentary Rock image. C. Thin section with different types of grains marked up.

Future Work

We are currently in the first year of the project and are working on selecting and developing all types of sedimentology educational materials, writing modules on sedimentology, and conducting control group data collection. All educational materials will be designed to use in the control group (without SedimentSketch), and then repeated using SedimentSketch in the test group. Additionally, we are working on the initial user interface design and development of the pilot version of SedimentSketch.

In years two and three, we will complete SedimentSketch development, test it in the classroom, and work on assessment data analysis and evaluation.

1 Acknowledgements

This work was supported by the National Science Foundation under Grant “HSI Implementation and Evaluation Project: SedimentSketch, teaching tool in and beyond the sedimentology classroom to provide equitable and inclusive learning for Hispanic students” #2318386.

References

- [1] R. S. Cottrell, “Student performance in online classes at a hispanic-serving institution: A study of the impact of student characteristics in online learning.” *Online Learning*, vol. 25, no. 3, pp. 18–35, 2021.
- [2] D. L. Davis, “Combining active learning approaches for improving computing course outcomes at minority-majority institutions,” in *2017 ASEE Annual Conference & Exposition*, 2017.
- [3] R. S. Cottrell, “Student outcomes in online and face-to-face classes at a hispanic-serving institution (hsi),” Ph.D. dissertation, University of Denver, 2020.
- [4] R. M. Felder, “North carolina state university, linda k. silverman,” *Institute for the Study of Advanced*

Development: Learning and Teaching Styles In Engineering Education, in Engr. Education, vol. 78, no. 7, pp. 674–681, 1988.

- [5] D. J. Peart, “Hand drawing as a tool to facilitate understanding in undergraduate human biology: a critical review of the literature and future perspectives,” *Studies in Science Education*, vol. 58, no. 1, pp. 81–93, 2022.