Board 416: Undergraduate Student Experiences With FossilSketch Software to Learn Basics of Micropaleontology

Dr. 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 Department of Multidisciplinary Engineering, Texas A &M University. Dr. Anwar has over 13 years of teaching experience, primarily in the disciplines of engineering education, computer science and software engineering. Her research focuses on studying the unique contribution of different instructional strategies on students' learning and motivation. Also, she is interested in designing interventions that help in understanding conceptually hard concepts in STEM courses. Dr. Anwar is the recipient of the 2020 outstanding researcher award by the School of Engineering Education, Purdue University. Also, she was the recipient of the "President of Pakistan Merit and Talent Scholarship" for her undergraduate studies.

Christina Belanger

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.

Dr. Christine A Stanley, Texas A&M University

Christine A. Stanley is regents professor of higher education, holder of the Ruth Harrington Endowed Chair, and vice president and associate provost for diversity emerita in the School of Education and Human Development at Texas A&M University. She served the university in administrative roles including vice president for diversity, executive associate dean, associate dean of faculties, and assistant department head. Her publications include Faculty of Color: Teaching in Predominantly White Colleges and Universities, and her scholarship has appeared in American Educational Research Journal and Educational Researcher. She is the recipient of departmental, college, university and national awards for faculty and graduate student mentoring, faculty development, and diversity and inclusion including the named, Christine A. Stanley Award for Diversity and Inclusion Research in Educational Development, created by the Professional and Organizational Development (POD) Network in Higher Education. Dr. Stanley has consulted nationally and internationally in Armenia, Canada, China, Mexico, and South Africa on issues related to faculty development.

Undergraduate Student Experiences With FossilSketch Software to Learn Basics of Micropaleontology

Anna Stepanova, Saira Anwar, Christina Belanger, Tracy Hammond, Christine Stanley

Abstract

We developed FossilSketch to enable instructors to teach undergraduate micropaleontology and provide students with a scaffolded interactive learning experience to help them develop microfossil identification skills. Here we report the results of FossilSketch testing, its effectiveness, and its impact on student learning experiences and knowledge retention. Junior and Senior undergraduate geoscience students at Texas A&M University learned microfossil identification in Spring 2020 (Control Group) through traditional means, and in 2021-2022 students learned with the aid of FossilSketch (Test Group). Students in the Test Group reported less confusion about the process of identifying the microfossils, and classroom assessment measures revealed that using FossilSketch resulted in statistically significant learning improvement. A qualitative analysis of open-ended student survey responses showed that students in the Test group shared more positive experiences and attitudes toward micropaleontology than those in the Control group.

Background and motivation

The microfossil remains preserved in sediments play key roles in determining the ages of geologic records, reconstructing paleoenvironments, and monitoring modern ecosystems [1–3]. However, training undergraduates to identify these microfossils requires a lot of time, and most students are not exposed to micropaleontology in their courses, which limits the number of future specialists entering fields that use them [4].

We developed FossilSketch [5], an interactive software that introduces students to micropaleontology through educational videos, mini-games, and exercises focused on their applications in geosciences, to enable teaching and learning of undergraduates in the basics of micropaleontology in undergraduate geoscience courses. FossilSketch allows students to sketch on touchscreen devices and provides instantaneous feedback to users on their sketches and microfossil identifications (Fig. 1). FossilSketch focuses on identifying benthic Foraminifera and Ostracoda from high-resolution photomicrographs. Foraminifera and Ostracoda are commonly used microfossils with industrial, environmental, and scientific applications. Foraminifera are amoeboid protists with a calcareous shell that are often abundant in marine environments, and Ostracoda are micro-crustaceans with a bivalved calcareous carapace that are found in all aquatic environments [6, 7]. Interactive identification exercises guide students through the characteristic

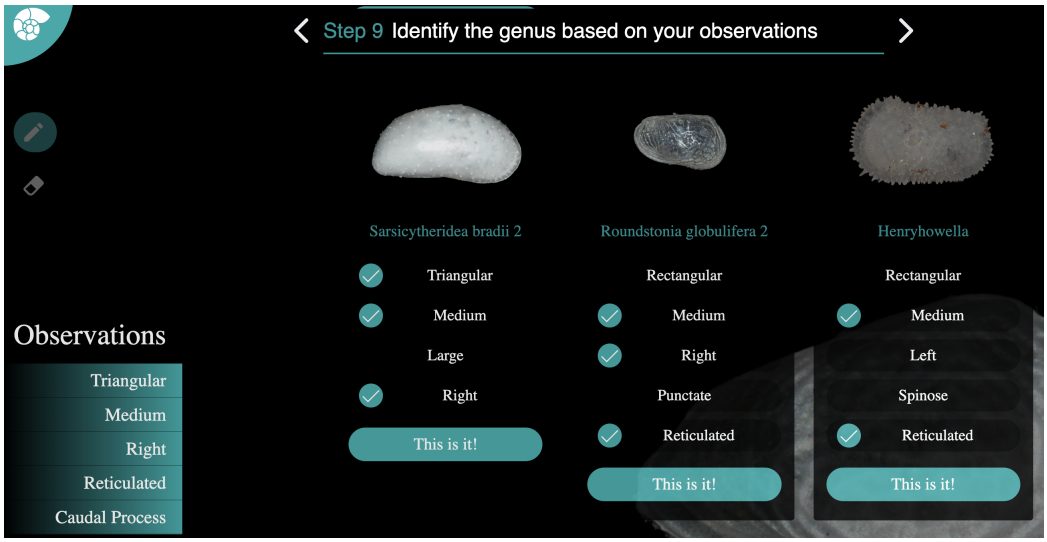

Figure 1: The last screen in identification algorithm for Ostracoda, where user can all selected features onthe left, and a list of genera in the database with these features matching

morphologic features and the principles of genus-level identification for Foraminifera and Ostracoda and morphotype identification for Foraminifera. The software integrates mini-game activities to help students practice identifying individual features before combining their skills to fully identify common genera or morphotype. Integrating ecologically relevant morphotype concepts allows inexperienced students to develop the skills necessary for making rapid environmental assessments from fossil data. Exercises to interpret microfossil assemblages allow students to apply their identification skills and have an insight into various applications of micropaleontology in research and industry. FossilSketch environment allows students to practice and receive feedback in real-time with little to no instructor supervision.

Study Goals and Research Questions

The main research goal of this project was to develop and evaluate the effectiveness of FossilSketch and its impact on student learning experiences and knowledge retention.

The following research questions were assessed:

- RQ1: To what extent does student comprehension and retention of micropaleontology knowledge increase (or decrease) after using FossilSketch?
- RQ2: To what extent does students' interest in and perception of micropaleontology as beneficial for them in the future improves after using FossilSketch?

Methods

We used qualitative and quantitative data analysis on student surveys and classroom assessments to answer our research questions. Junior and Senior undergraduate geoscience students at Texas A&M University, Paleontology and Geobiology class learned microfossil identification in Spring

2020 (Control Group, 51 students) through traditional means involving diagrams and specimens viewed through a stereoscope. Students in 2021 and 2022 (Test Group, 61 students) learned microfossil identification with the aid of FossilSketch. In Spring 2021, students had the option to participate in class remotely or in-person, and all the activities were made available through FossilSketch; and 2022 students could still participate remotely, but majority of the students were back to in-person mode, and one of the classes had to be remote due to the snow storm.

Results

Classroom assessment measures revealed that using FossilSketch resulted in statistically significant learning improvement, as evidenced by classroom assessment of performance scores and motivation, with students reporting that they felt more successful at independent learning and better prepared for a micropaleontology lab. A qualitative analysis of open-ended student survey responses showed that students in the Test group shared more positive experiences and attitudes towards micropaleontology than in the Control group. We recorded a significant improvement in the number of students who found that micropaleontology knowledge would be beneficial for them in the future from the control to test group. It is noteworthy that between the two Test years, 2021 and 2022, 2021 was more positive, possibly because students in 2021 had an option of attending the class in a hybrid mode, while in 2022 they could still choose to be remote, but majority of the students was back to be in-person mode.

Conclusions

FossilSketch is the first software that allows for remote teaching of a traditionally only lab-based subject, micropaleontology, and, because of built-in feedback, it allows students to effectively learn and practice micropaleontology. Statistically significant changes in the percentage of students who became more aware of the usefulness of microfossils after using FossilSketch and improvement in students' scores on classroom assessments allow us to conclude that the use of FossilSketch helped students to learn more efficiently.

Our goal was to evaluate its impact on student learning experiences and knowledge retention. Based on the data we collected, including both qualitative and quantitative measures, FossilSketch was a successful tool: (1) to increase student comprehension and retention of micropaleontology knowledge, and, (2) to improve student interest and perception of micropaleontology and its applications as useful for their future careers.

FossilSketch supports instructors, including non-experts, in teaching micropaleontology and provides a useful tool for use in outreach activities and in industry. We will present the current FossilSketch interface and the most recent data at ASEE 2023 NSF grantees poster session.

1 Acknowledgements

This work was supported by the National Science Foundation under Grant "Developing a Digital Sketching Application That Delivers Personalized Feedback to Improve Student Learning and Engagement in Micropaleontolog" #1937827.

References

[1] R. W. Jones, *Foraminifera and their Applications*. Cambridge University Press, 2013.

[2] J. W. Murray, *Ecology and applications of benthic foraminifera*. Cambridge university press, 2006.

[3] L. Capotondi, C. Bergami, G. Orsini, M. Ravaioli, P. Colantoni, and S. Galeotti, "Benthic foraminifera for environmental monitoring: a case study in the central adriatic continental shelf," *Environmental Science and Pollution Research*, vol. 22, pp. 6034–6049, 2015.

[4] B. J. Tewksbury, C. A. Manduca, D. W. Mogk, R. H. Macdonald, and M. Bickford, "Geoscience education for the anthropocene," *Geological Society of America Special Papers*, vol. 501, pp. 189–201, 2013.

[5] "Fossilsketch website," https://fossilsketch.org/.

[6] H. A. Armstrong and M. D. Brasier, "Foraminifera," *Microfossils, Second Edition*, pp. 142–187, 2005.

[7] A. J. Smith, D. J. Horne, K. Martens, and I. Schön, "Class ostracoda," in *Thorp and Covich's freshwater invertebrates*. Elsevier, 2015, pp. 757–780.