





Motivation

- Even though the need for computational training is clearly recognized, the most effective way to accomplish this is not well understood, especially at the undergraduate level.
- There is no standard place for students to develop scientific computing skills. Some undergraduates gain scientific computing skills through participation in research or within a course. However, these opportunities focus on learning of disciplinary content rather than development of scientific computing and data analysis.
- One potential option is to provide training for scientific computing online as it could be available beyond a single institution and enable participants to shift between the instructional mode and computer analysis more seamlessly than in a lecture hall environment.

Math Skills Critical Thinking

student learning outcomes. Figure from Haberli et al., 2024

What is the Seismology Skill Building Workshop?

- The SSBW is an online (MOOC-like), certificate granting, asynchronous opportunity that is 14weeks long with around 6 hours per week of work.
- The workshop centers on computer programming in the context of seismology.
- It consists of 6 modules with approximately 6 tutorial assignments per module.
- Provides immediate feedback and allows participants to re-take questions based on feedback.





Scientific Computing Tutorials

- Students enter code on a tailored virtual machine
- Practice key syntax and parameter options
- Use different types of data common in seismology
- Encourage debugging strategies to identify errors

- Questions with automatedgrading for students to check understanding
- Immediate tailored feedback to wrong answers
- Students re-answer for partial credit (- $\frac{1}{3}$ for incorrect attempt)
- Reinforces the "learn from mistakes" attitude towards learning

Critical Thinking

- Program products designed to illustrate seismology concepts
- Application of numeracy and spatial
- reasoning Cumulative learning requires use of prior knowledge/skills

The Large-Enrollment Seismology Skill Building Workshop as a Geoscience Recruiting Tool

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Interactive LMS Assignments



D (blue) values are shown as circles. Error bars are calculated from the standard deviation of student performance

- overall active e-learning pedagogy is enabling higher order skill development





Figure 4: Number of registered participants in the USA (top) and internationally (bottom) per year.

Diverse Workshop Participation



Figure 5: Number of participants per year that took the workshop but do not major in geoscience.

- Even though the workshop targets seismology skills, about a third of participants are non-geoscience majors, resulting in over 200 students per year who can potentially be recruited to geoscience.
- Participation of women and marginalized groups among students in the USA has been substantially higher than the percentage of undergraduate geoscience degrees awarded (Gonzales and Keane, 2020).

• Gains in performance for higher order thinking questions show larger effect sizes (Haberli et al., 2024). • Despite less higher order thinking questions, students improve more at analyzing skills, indicating that the

Large and Widespread Enrollments

• The USA participation had many registrants during the pandemic (summer of 2020) due to limited in-person internship opportunities. • The following years for the USA participants have lower numbers overall but an increasing trend can be observed in the years following. • International participation has been generally increasing since 2020,

with 2024 having the largest participation almost doubling the number of registrants from the previous year.

Typically, there is participation from at least 60 different countries



	2020 SSBW	2024 SSBW	Undergrad Geoscience Degrees
icipation of Women	59%	62%	46 %
icipation of alized Groups	29%	32%	15%

Impact on Marginalized Groups in the USA

Survey Quest

- N=57 (35, 22) US Co Interest in Seismology
- concepts Interest in Graduate so seismology/geoph Interest in Employmer
- seismology/geophysics

Survey Qu

How likely are you to seismology (e.g., class How likely are you to p school in seismology/g

Performance of Different Student Groups

Assignment	White + Asian Groups (n=29)	Marginalized Groups (n=13)		
Pre-Test Score	80.8%	78.7%		
Post-Test Score	84.4%	83.9%		
Normalized Gain	18.5%	24.3%		
 Slightly higher Pre-to-Post test gains in perforn Marginalized Groups. 				

- with initiation or completion.

backgrounds achieve and pursue geoscience at the Same rate when the playing field is leveled.

Brudzinski, M., M. Hubenthal, S. Fasola, and E. Schnorr (2021). Learning in a Crisis: Online Skill Building Workshop Addresses Immediate Pandemic Needs and Offers Possibilities for Future Trainings, Seismological Research Letters 92, no. 5, 3215–3230, doi: 10.1785/0220200472. Gonzales, L., and C. Keane (2020). Diversity in the Geosciences, American Geological Institute (AGI): Geoscience Currents, Data Brief 2020-023. Hubenthal, M., M. Brudzinski (2024). Undergraduate Persistence in an Open-Access, Online, Scientific Computing Training Is Influenced by **Expectancy, Value, and Cost,** Journal of Geoscience Education, Accepted. Haberli, G, M. Brudzinski, M. Hubenthal (2024) Advancing Scientific Computing Skills and Diversity in the Geosciences Through Asynchronous Learning at the Margins of Higher Education, Earth Educators Rendezvouz, July 2024, Philadelphia, Pennsylvania



Looking to expand your current skill set?



Scan and Sign up to be notified when the registration for the Workshop opens.

SSBW typically runs from the beginning of June to the end of August.

ions	White + Asian Groups		Marginalized Groups			
mpleters	Before	After	Gain	Before	After	Gain
/Geophysics	4.12	4.24	14%	3.95	4.47	50%
chool in ysics	3.61	3.94	23%	3.37	4.05	42%
nt in Vsics	3.75	3.78	3%	3.53	4.26	50%

5	Extermely
4	Very
3	Somewhat
2	Not so much
1	Not at all

Figure 6: Scale used to answer the questions and their respective numerical value.

 Interest in seismology/geophysics including grad school and employment for marginalized students were lower before and higher after compared to others.

estions	White + Asian Groups	Marginalized Groups	5 4 3	Extermely likely Somewhat likely Neither likely nor unlikely	
earn more about or internship)?	4.37	4.42	2 1	Somewhat unlikely Extermely unlikely	
oursue graduate geophysics?	4.12	4.12	Figure 7: Scale used to answer the questions and their respective numerical value.		

Likeliness for students in the USA to pursue seismology and/or graduate school was similar between the two groups.

> • Increasing interest in seismology/geophysics and providing the necessary skills ensures equal opportunities for entry and participation in the field.

mance for students from

Initiation and Completion

Hubenthal & Brudzinski (2024) explored how participant's perceptions of expectancy, value, and cost influence their initiation and completion.



generalized association to the SSBW, where expectancy is a student's perception of ability to complete tasks, value is perception of task merit, and cost is perception of consequences for participating, some of which may be unanticipated. Figure and caption from Hubenthal & Brudzinski (2024).

References