Developing an understanding of the Seismology Learning Ecosystem and its connection to the Seismology Skill Building Workshop: What are students learning in introductory seismology classes and how are they learning it?

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Abstract

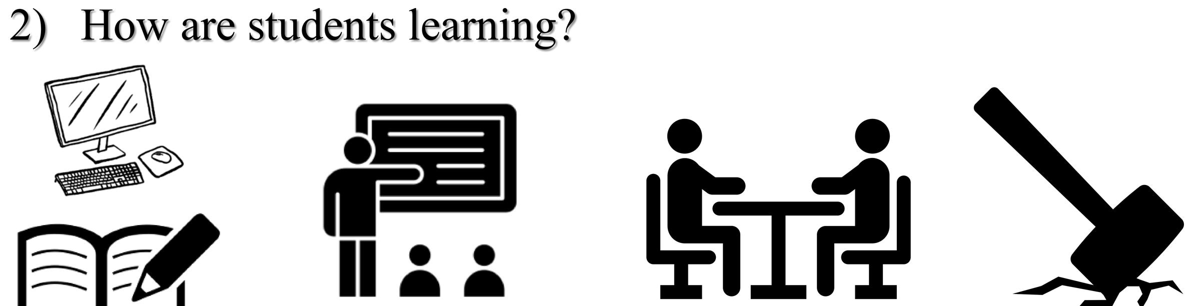
The Seismology Skill Building workshop is a 12-week, Massive Open Online Course (MOOC) established **in 2020. The course has three primary goals: to help students gain scientific computing skills, to increase interest in seismology, and to prepare students for graduate programs and give them a competitive edge in the application process.** The workshop features tutorials with feedback-driven activities and weekly webinars for more complex topics. The number of students has doubled since its inception, from 700 students enrolled in the first workshop to over 1,400 in the fourth iteration (2024). Results from 2021/2022 indicate that SSBW participants improved their scientific computation skills by 37%, interest in seismology and scientific computing by 32%, and readiness for graduate studies and/or careers in seismology by 32%. **To fully understand the relevance and impact of the SSBW and ensure the optimization of this course for students, we need to understand its position within the broader seismology learning ecosystem (SLE). This project aims to define the scope and sequence of introductory seismology courses, the instructional methods used, and the scientific computing taught in these classes.** This is accomplished through an analysis of 7 introductory seismology course syllabi combined with follow up surveys to professors of these courses to gain a deeper understanding of the introductory seismology courses. Results are used to benchmark and assess SSBW's ability to prepare students for success in these courses, as well as graduate work. Additionally, the SLE review aims to help current professors evaluate and improve their courses, and guide early-career seismology professors as they build their own curriculum. Finally, the SLE review will be used to build an open-source, non-workshop based resource for students interested in seismology graduate programs, promoting diversity and equity in the field.

Seismology Learning Ecosystem: Three areas of interest

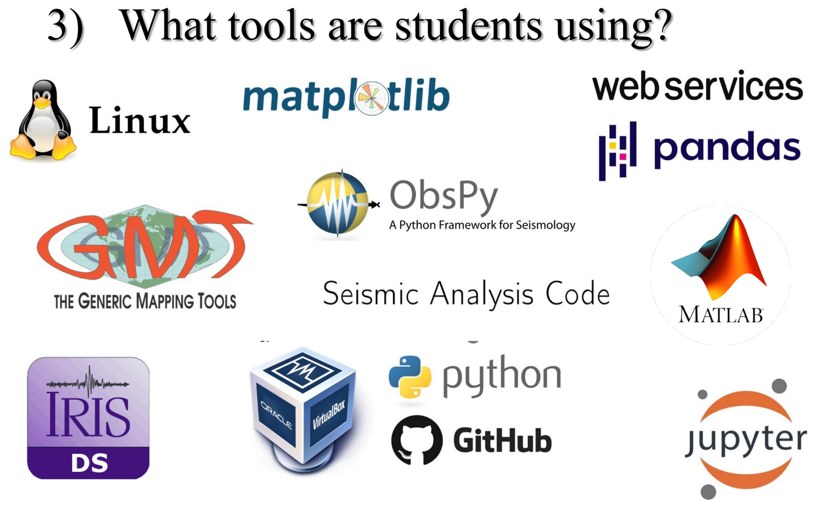
1) What are students learning?

	Instruction	Expectation of Learner	Bloom's Levels of Understanding
5	This topic is the focus of multiple assignments and discussions	Students can draw connections between this topic and other course content	Analyze
4	This topic is the focus of an assignment that students complete	Students can use their knowledge of the topic to complete assignments	Apply
3	This topic is discussed in class	Students can explain the topic	Understand
2	This topic is mentioned, but briefly in relation to another topic	Students can recall facts about the topic	Remember
1	This topic is not mentioned	Not familiar with the topic	None

2) How are students learning?

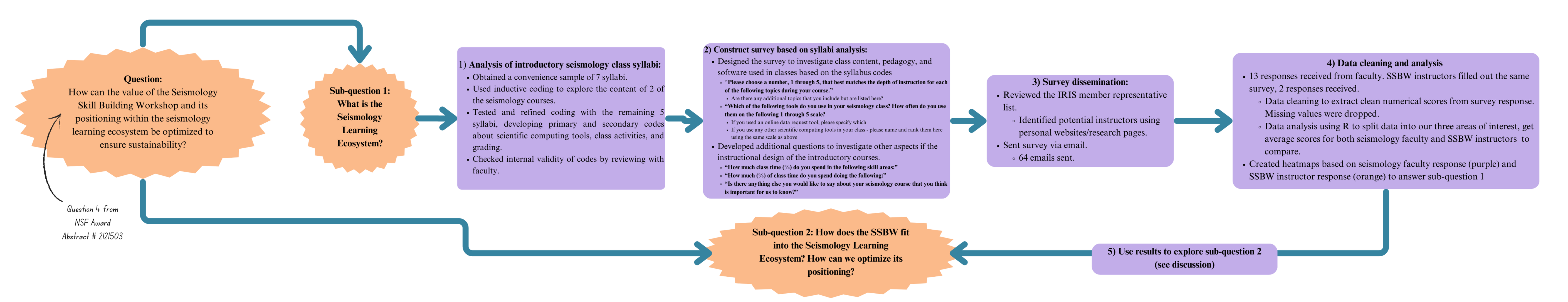


3) What tools are students using?



Score	Explanation
5	Tool is used 4 or more times during the course
4	Tool is used 2-3 times by students during the course
3	Tool is used once by students during the course
2	Tool is shown by professor, but not used by students during the course
1	Tool is never mentioned during the course

Methodology



Results

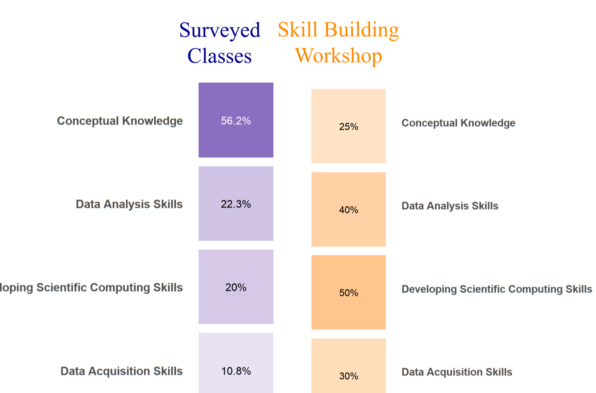
What are students learning?

"Please choose a number, 1 through 5, that best matches the depth of instruction of the topic during your course"

Figure 1: Comparison of seismology concepts included in introductory-level seismology classes and the SSBW using averaged scores from the scale. The SSBW discusses (3: This topic is discussed in class) less content (14 items) then the surveyed courses (26 items). However, the two emphasize a similar number of topics (4: This topic is the focus of an assignment that students complete) with the surveyed courses focusing on 8 items while the SSBW focuses on 6 items with 2 of those as the focus of multiple assignments and discussions.

What are students learning?

How much class time (%) do you spend in the following skill areas:



Comparison of the average percentage of instructional time spent in surveyed classes vs. the SSBW on different knowledge and skill areas. The largest percentage of instructional time in the surveyed classes (56%) is spent on developing conceptual knowledge. This appears to largely occur in isolation of the other skills as the total time allocation is 109% for all the skills. In contrast the, the SSBW only spends 25% of time developing content knowledge. However, it appears to do so while also developing other skills as the total time allocation for all the skills is 145% for the SSBW.

How are students learning?

How much (%) of class time do you spend doing the following:

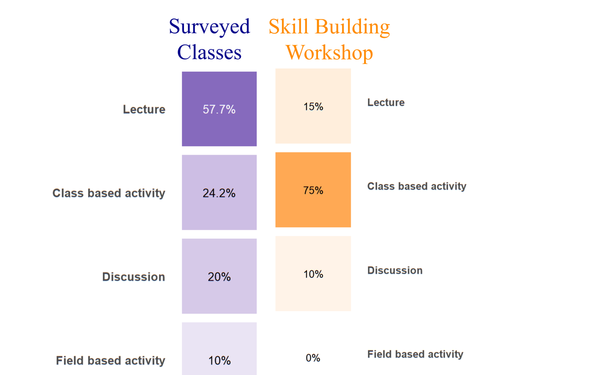


Figure 3: Comparison of the percentage of instructional time spent using various pedagogies employed in the surveyed classes and the SSBW. The SSBW employes an active e-learning pedagogy to engage learners in the course material through class activities, while surveyed courses tend to rely on more traditional instructional methods such as lecture.

What are students learning?

How does conceptual instruction match up?

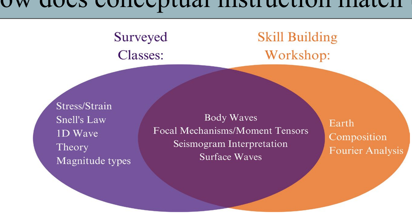


Figure 4: Comparison of **focus topics** in surveyed classes vs. the SSBW. Focus topics score an average of 4 or above: "**This topic is the focus of an assignment that students complete**"

What tools are students using?

Which of the following tools do you use in your seismology class? How often do you use them?

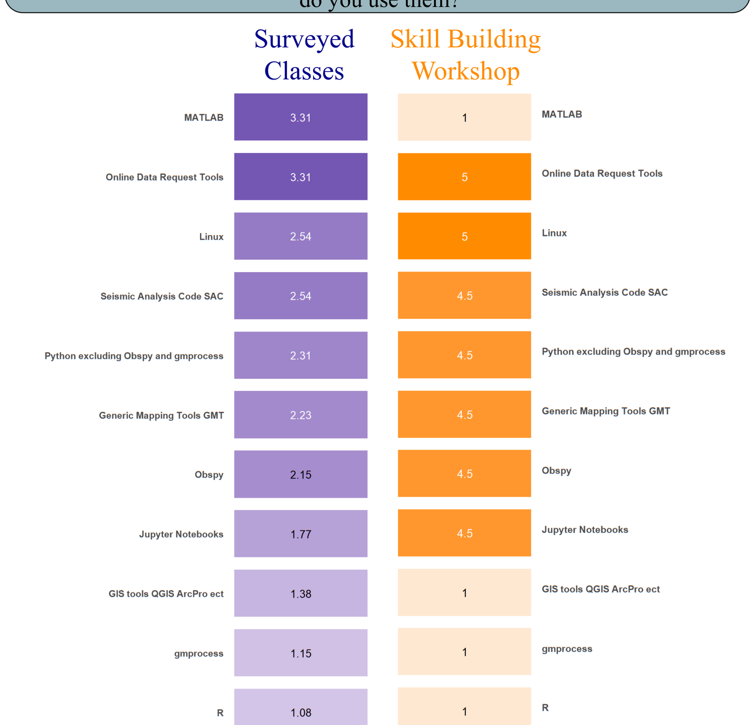
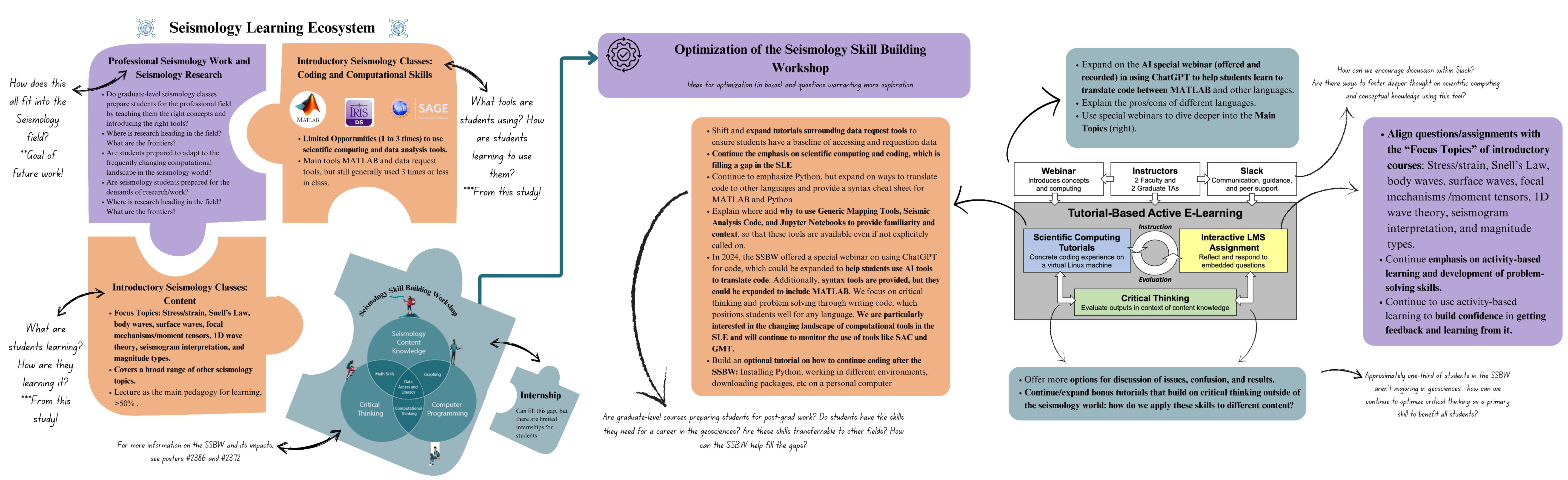


Figure 5: Comparison of averaged scores for the use of scientific computing and data analysis tools used (scale to the left) in the surveyed classes and the SSBW. In the surveyed classes Matlab is the most frequently used tool (on average once). In the SSBW seven different tools are used three or more times on average. Python is used in the SSBW because it is open-source and free vs. MATLAB

Discussion:



Additional Projects Using these Results:

- Because the SSBW is free, the main barrier to entry and completion for students is often time and energy during busy summers. These results will aid in building an open-source, asynchronous, "mini-workshop" tool for students that may not be able to commit to the entire workshop.

- These results will also be used to develop resources to assist early career faculty who want to plan new courses and senior faculty who want to revise their courses.
- We hope to foster a dialogue about the current seismology learning ecosystem: What is working? What isn't?

- We would like to employ a similar survey approach to gain insight into the day-to-day scientific computing tools, seismology concepts, and critical thinking involved for working seismologists and seismology research to continue to optimize the SSBW and the seismology learning ecosystem as a whole.

Acknowledgements

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For more information on the SSBW and its impacts, see posters #2386 and #2372

Do you teach an introductory seismology class?? Help us gather more data! Scan the QR code here and fill out our survey!