

Making Nuclear Magnetic Resonance Resonate With Students

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WHY NMR?

**IMPORTANT
RESEARCH TOOL**

CROSS-DISCIPLINARY

NMR

**BRIDGE TO 21st
CENTURY CAREERS**

ACCESSIBLE

PROJECT GOALS

Developed curricular materials are interdisciplinary and *make use of current pedagogical best practices for an engaged and inclusive science learning environment.*

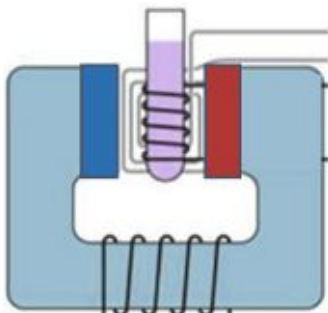
Curricular materials provide students with class-based undergraduate laboratory experiences that introduce **research skills** and **emulate experimental research in a lab** (with or without direct access to an NMR system).

Curricular materials are *designed to be easily adapted and adopted* for use in a wide array of educational environments.



WHAT WE HAVE DEVELOPED

Making NMR Resonate



Module 1: Why Magnetic Resonance?

[Module 1 - PDF](#)

[Module 1 - Student Worksheet](#)

Module 1 Instructional Materials

[Module 1 - Instructor's Manual](#)

[Module 1 - Instructional Slides with Links to Supplemental Materials and Module Assessments](#)

[Module 1 - Student Worksheet Answers](#)

[Module 1 - Feedback Form](#)

MODULES CONTAIN:

- Expected learning outcomes
- Real-world examples
- Featured scientists
- Hands-on activities, simulations, videos of experiments for those without access to equipment
- Research-based pedagogy

▼ Home

^ Physics Modules

Module 1

Module 2

Module 3

Module 4

Module 5

Module 6

Module 7

Module 8

Module 9

Module 10

Chemistry Modules

UNDERGRADUATE RESEARCHERS



Sarah Lawrence College

Lillian Bower

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Leah Goodall

Jane Joncha

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Christina Kefela

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Christian Tarrasch

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Mahisha Akhand

Bibi Zameena Alli

Sophia Jiang

Sammely Perez

Racquel Scott

Taylor Tram

The 2023 summer crew visiting the NMR facility at CCNY.

Where we are now

Implementations: Implemented all the modules at Sarah Lawrence College, and 4 modules at City College of New York.

Revising the materials and creating instructional materials.

Disseminating our work online as well as leading professional development workshops for faculty to learn how to best adapt the material for their particular needs.

OVERALL

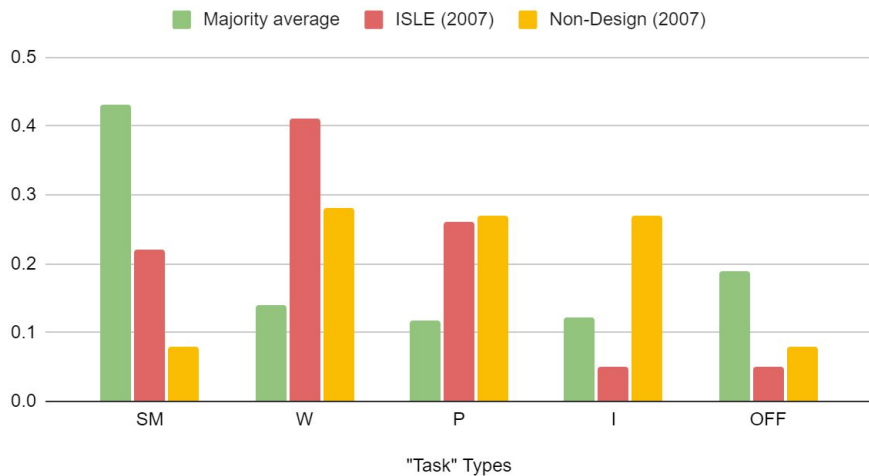
based off instructor and student feedback

- Most of the desired learning objectives are being met
- Students enjoyed using the modules
- Instructors noticed that students were engaged and had increased confidence in answering questions and explaining their reasoning
- Instructors had a very positive experience using the modules and felt that they helped students develop skills in the techniques or procedures of science

LESSONS LEARNED FROM EVALUATION

Students spend a LOT of time sense making (not a lot writing)

Percent Time on "Task" (Fall Modules 7, 8 and 9)



Content assessments have **strong scores for all students**

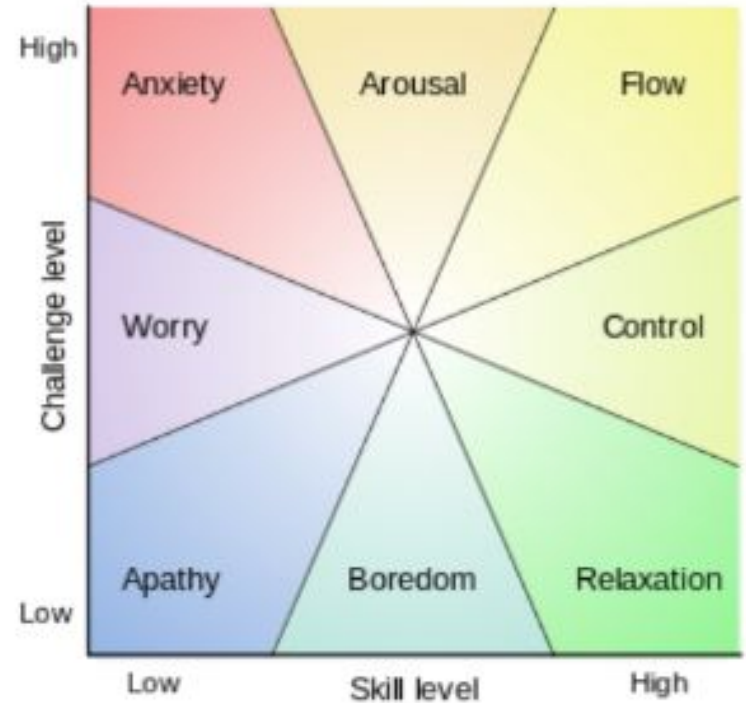
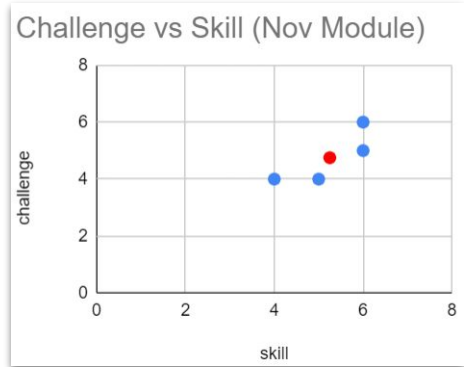
No notable identity shifts - their identities as scientists started and remained strong

Unsurprisingly, **no notable ECLASS shift**

* these are VERY small N results

LESSONS LEARNED FROM EVALUATION

FLOW*: mental state in which a person performing some activity is fully immersed in a feeling of energized focus, full involvement, and enjoyment in the process of the activity



*Named by Csíkszentmihályi in 1970

LESSONS LEARNED FROM EVALUATION

25 Ranked Statements:

Teachers > Students: Laboratory experiments develop skill in the techniques or procedures of physics.

BOTH: Students discuss their data and conclusions with each other.

Students > Teachers: Students follow the step-by-step instructions in the laboratory guide.

Q SORT

Very much agrees			LEAVE BLANK			
agrees						LEAVE BLANK
Neutral						
disagrees						LEAVE BLANK
Very much disagrees			LEAVE BLANK			
1. Students follow the step-by-step instructions in the laboratory guide.	5. Laboratory activities are used to develop concepts.	8. During laboratory students record information requested by the instructor or the laboratory guide.	13. The instructor or laboratory guide requires that students explain why certain things happen.	16. Questions in the laboratory guide require that students use evidence to back up their conclusions.	19. During laboratory students record the information they feel is important.	23. In discussion with the instructor, assumptions are challenged and conclusions must be justified.
2. Questions in the laboratory guide require the interpretation of data.	6. The instructor lectures to the whole class.	10. The instructor or laboratory guide identifies the problem to be investigated.	14. Laboratory is used to investigate a problem that comes up in lecture.	17. Students discuss their data and conclusions with each other.	20. Students propose their own explanations for observed phenomenon.	24. Students usually know the general outcome of an experiment before doing the experiment.
3. The instructor is concerned with the correctness of the data.	7. Students are asked to design their own experiments.	11. Laboratory activities require students to solve problems.	15. Laboratory experiments develop skill in the techniques or procedures of physics.	18. The instructor or laboratory guide asks students to state alternative explanations of observed phenomenon.	21. Students identify problems to be investigated.	25. The instructor gives information to individuals in small groups.
4. Students are allowed to go beyond regular laboratory exercises and do experiments on their own.	9. Laboratory sessions raise new problems or result in data that cannot be immediately explained.	12. The laboratory guide requires that specific questions be answered.			22. During laboratory students check the correctness of their work with the instructor.	

INTERESTED IN USING OUR MATERIALS?

This project is designed to benefit all undergraduate science programs but will have the **most impact at primarily undergraduate institutions with limited access to research experiences and historically underserved student populations.**

[Scan the QR code](#) to be contacted when the materials are available and/or to provide suggestions of potential resources to include!

