Transforming the *Dimensions of Success* for Middle School Science and Engineering (DoS-MSSE)

ISRY Institute for the Study of Resilience in Youth

Learn more about DoS-MSSE!

Rutgers Graduate School of Education

Mass General Brigham McLean

HARVARD MEDICAL SCHOOL AFFILIATE

Gil G. Noam, Ed.D., Dr. Habil (Project PI) | Patricia J. Allen, Ph.D. (Co-PI) | Drew H. Gitomer, Ph.D. (Co-PI)

gil_noam@hms.harvard.edu | www.isry.org

INTRODUCTION

- The STEM education field needs reliable and valid assessments that clearly define quality across STEM learning settings.
- The **Dimensions of Success (DoS) framework** is an empirical **STEM observation tool and feedback system for out-of-school time (OST)**[1] that provides a common language and data to identify strengths and challenges and support continuous improvement.[2]
- The DoS framework is organized into **12 dimensions of quality** across four domains (Figure 1).
- Certified DoS observers record detailed field notes of student and educator interactions (comments and behaviors) during a STEM lesson/activity. Observers quantify their evidence using a 4-point scale (1, Evidence Absent to 4, Compelling Evidence).

OUR GOALS

This study's purpose is to validate DoS for middle school science and engineering (MSSE) classrooms. Our specific goals are to:

1. Align DoS with new science and engineering standards
2. Increase measurable principles of diversity, equity, inclusion, and access (DEIA) in the context of science and engineering
3. Establish a video observation protocol to increase access to the DoS framework for continuous improvement
4. Create local and national portraits of STEM quality and outcomes

6th Grade Engineering Classroom Video, Link: https://www.youtube.com/watch?v=ZxRLV3qUev4

8th Grade Science Classroom Video, Link: https://vimeo.com/122049840

RESEARCH DESIGN

This study employs a **cross-sectional, mixed-methods design** that brings together **observation ratings, student/teacher survey ratings, and school- and classroom-level administrative data** to **validate** the **DoS-MSSE** protocol. We will apply Kane's (2006) model[3] for validation:

1. Scoring (correlation and factor analyses)
2. Generalization (variance components analyses)
3. Extrapolation (hierarchical linear modeling using observation ratings as a predictor)
4. Implication (expert review of protocols/scale points)

Table 1. DoS-MSSE Project Activities (as of March 2023)

Activity	Number
Literature Articles Reviewed (i.e., STEM, SED, DEIA, Methods)	71
Advisory Meetings (i.e., Researchers +/- MSSE Teachers/Coaches)	10
District and School Partner Meetings (i.e., Principals, Coordinators)	23
Classroom Observation Records (Two to six observers per observation)	267
Research Team Scoring Calibration Sessions (all raters per observation)	22
Teacher Feedback Sessions (two observers and teacher)	4
Observers Trained/Certified in DoS (including OST and MSSE)	6

KEY DISCOVERY #1: CROSS-SETTING APPLICATION

A quality framework initially developed for OST can be translated to schools (see Figure 1, Table 2). The same domains and dimensions are relevant, and new indicators are added to align better with school context, the new vision for STEM, and SED, and equity.

Figure 1. The DoS-MSSE Domains and Dimensions

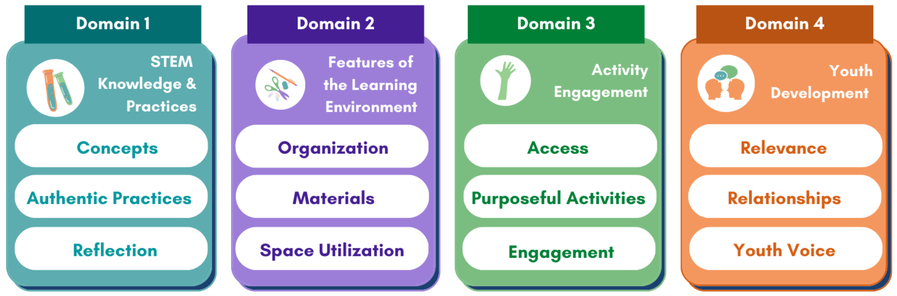

Table 2. Transforming the "Youth Voice" Dimension – Out of school and in school

	Out-of-School-Time		Middle School Science and Engineering
Summary	Activities make connections with youth's lives, personal experiences, other subject areas or larger STEM issues. Activities help youth link STEM concepts to careers and community concerns. The rubric considers the extent to which both the facilitator and youth make these connections.	*Description*	This rubric considers the extent to which student ideas, opinions, questions, and contributions are elevated in the classroom.
Level 4	Youth are continually asked to weigh-in on their learning experience and to share their ideas and opinions about structuring the activity. | Youth have multiple opportunities to make decisions and choices within facilitator-selected constraints. Youth are able to take personal or group responsibility for important aspects of their learning/participation in the activities. | Youth have opportunities to share their ideas outside of the program to school/community members.	*Level 4*	Student contributions are consistently elaborated or built upon effectively by the teacher or other students (directly in a whole group or through small groups/partner sharing).
Level 3	Youth are often asked to share their ideas and opinions throughout the activities and encouraged to take a stance and have a voice in the activities. | The activities provide opportunities for youth to take ownership, incorporate their own ideas and opinions, and to share with others; however, these opportunities are limited in duration and quality. | Youth may also have opportunities to make some decisions and choices on their own, within appropriate constraints selected by the facilitator.	*Level 3*	Student contributions are occasionally elaborated or built upon by the teacher or other students (directly in a whole group or through small groups/partner sharing). Voices are never minimized during the lesson.
Level 2	The youth's voice is inconsistently supported during activities. The facilitator attempts to listen to youth ideas and opinions sometimes, but often falls back on more facilitator-centered approaches as well. | The activities allow youth to make some simple decisions (e.g., what animal to explore or which variable to use), but it is not sustained throughout the activity. | Youth can make some superficial choices about their learning experiences (e.g., where to sit, their team's name, etc.).	*Level 2*	Student contributions are encouraged and acknowledged by the teacher or other students (directly in a whole group or through small groups/partner sharing). Voices are not elaborated or built upon OR there are moments where voices are minimized during the lesson.
Level 1	Youth ideas may be expressed, but the facilitator does not acknowledge or address them, or explicitly shuts them down (e.g., interrupts the youth, or tells them it is not the time to discuss). The facilitator's voice is all that is heard and valued in the learning environment. | The activities do not allow for much ownership or initiative by the youth | Youth cannot influence decisions about their learning experience.	*Level 1*	Students are not encouraged to contribute to the classroom. If student contributions are made during whole group or small group discussions, they are either not acknowledged or outright dismissed by the teacher and/or peers.

KEY DISCOVERY #2: DEMAND FOR DOS-MSSE

Qualitative data support the desire among teachers and administrators for an observation-based continuous improvement tool for middle school science (as of June 2023, *n* = 4 individual interviews, *n* = 6 focus groups with 5 teachers/coaches) .

"I feel like **it's hard for science teachers to grow in this district because we're kind of like satellites.** We have a lot of support for curriculum and materials but not always [my actual] delivery… of the lesson."
- Grade 8 Science Teacher

"The best PD is to go into another person's classroom to observe…. **[DoS] hits the mark**…. You took it from a professional development… viewpoint [which] is **extremely helpful for me as a coach**."
– K-12 Science Instructional Lead

"I love examples. **What does this look like in my classroom? How can I utilize it in a future lesson?** Small things, maybe, to change ."
- Grade 6 Science Teacher

KEY DISCOVERY #3: SCHOOL CAPACITY

- Multiple districts and schools declined to participate in this study due to capacity, two of which have previously participated in NSF-sponsored research.
- One of two confirmed districts required multiple changes to research due to COVID-19 restrictions and staff shortages.

Table 3.A-B DoS-MSSE Recruitment Progress (as of June 2023)

3A. District Partner Status	Number
Districts Contacted^	39
No Response at All	8
No Response after Initial Interest^^	16
Districts Declined	13
Districts Confirmed	2

3B. School Partner Status	Number
Schools within Districts Contacted	37
No Response at All	24
No Response after Initial Interest^^	2
Schools Declined	6
Schools Confirmed	5

^ Recruitment efforts included national listserv outreach, individual outreach by project advisors, and outreach to STEM Ecosystem partners.
^^ For districts or schools that indicated interest, the research team sent at least 3 follow-up emails.

IMPACTS

Development of Human Resources
- Training in the DoS-MSSE framework
- Providing opportunities for professional development
- Bridging connections between OST and MSSE learning

Products
- Literature review on DEIA and SED in K-12 STEM
- Revised DoS-MSSE framework
- Revised DoS-MSSE rubrics
- DoS-MSSE observer training protocol
- Peer-reviewed article on features of SED in DoS-MSSE
- Student/teacher surveys (e.g., new STEM+SED items)

REFERENCES

[1]Shah, A. M., Wylie, C., Gitomer, D. H., & Noam, G. G. (2018). Improving STEM program quality in out-of-school-time: Tool development and validation. *Science Education*, *102*(2), 238–259. https://doi.org/10.1002/sce.21327

[2]Browne, R. K., Allen, P. J., & Noam, G. G. (2021). The double-dip: quality discrepancies in out-of-school time STEM programs. *International Journal of Science* Education, Part B, *11*(1), 35-54. https://doi.org/10.1080/21548455.2020.1866787

[3]Kane, M.T. (2006). In Brennan R. L. National Council on Measurement in Education & American Council on Education. (2006). *Educational measurement* (4th ed.). Praeger.

ACKNOWLEDGEMENTS

This project is funded by the National Science Foundation, grant #2101554. Any opinions, findings, and conclusions or recommendations expressed in these materials are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

We thank our teacher participants and project advisors for their feedback and thoughtful contributions on the DoS-MSSE tool. We appreciate our school partners and students who have participated in classroom observations throughout this project.

We also thank our project team members from ISRY (Virginia Andrews, Victoria Oliveira, and Sara Hoots) and Rutgers University (Aaron Rabinowitz) and our consultants (Ashima Shah, Cary Sneider, Andrés Henríquez).