

# Engaging Underserved Audiences with Materials Science

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## *Why Informal Science Education (ISE) matters*

While formal, classroom-based science and math education are important, they are of limited duration in a person's lifetime and the content is largely chosen by people or groups other than the learner. On the other hand, Informal STEM (science, technology, engineering, and math) Education (ISE) involves lifelong and primarily participant-directed learning through a broad range of experiences that include museums, libraries, zoos, afterschool programs, and outreach events. Given that people spend less than 9% (1) (2) of their lifetime learning in formal classrooms, and many people report that their science understanding comes over the course of their lives from many sources outside of formal education (3), ISE is an important factor in creating a scientifically engaged and literate population. Furthermore, people pursuing STEM-related careers report that science experiences outside of school influenced their interest in STEM (4) (5), and young students who expect to have a career in science are more likely to graduate with a science degree (6), suggesting that ISE is also important in growing the future STEM workforce.

## *Why some people don't engage in ISE*

While most people have opportunities to experience classroom-based science and math education, people who engage in ISE in the U.S. typically come from more affluent and ethnically dominant backgrounds (7). Lack of engagement may be due to several, potentially overlapping barriers including cost, geographic distance, language fluency, low interest, and no sense of belonging (7). Recent research also suggests that gender, race, ethnicity, and economic status play a larger role in whether people engage with ISE than whether they participate in formal STEM education (8). Not surprisingly, groups that are underrepresented in ISE overlap with those that are historically underrepresented in materials science and engineering (MSE) fields.

## *The role of the Wisconsin MRSEC in ISE*

Broadening participation in STEM fields to include people who have been historically underrepresented is a goal that universities, funding agencies and societies across the U.S. agree is crucially important. The NSF funded Materials Research Science and Engineering Center (MRSEC) at the University of Wisconsin-Madison is no exception, and many of the Center's education/outreach programs are focused on engaging people from historically underrepresented audiences. Like many other groups engaged in ISE, the Wisconsin MRSEC struggles with how to effectively reach underserved audiences. Many of the Center's outreach events occur on the UW-Madison campus reaching thousands of people every year and the demographic data we collect at these events suggests that on-campus events targeted toward families or schools are primarily attended by majority demographic

audiences (e.g., the 2022 Engineering Expo on the UW-Madison campus had ~83% majority attendees). Conversely, outreach at afterschool programs or events targeted at underserved communities such as Juneteenth events reach more diverse audiences (e.g., a local 2023 on campus Juneteenth event had 84% underrepresented attendees). In an effort to reach community members who may not be able to attend on-campus events due to a lack of resources such as time, money or transportation, the MRSEC partnered with a local food pantry to provide science outreach to economically disadvantaged families onsite while they waited their turn to select food and household items at the pantry. Demographic data collected by pantry staff pre-pandemic showed that the pantry typically served about 1700 families every month (average household size of three - 2900 adults and 2200 children) with 32% of clients reporting they are African American/Black and 18% reporting they are Hispanic/Latino. In comparison, the 2022 Census indicates the population in Wisconsin is 6.6% Black/African American, 7.6% Hispanic/Latino, and 2.2% identify as two or more races (9). All of the food pantry clients had household incomes below the national poverty level.

Through this project, MRSEC members gained valuable insight into effective ways to engage vulnerable and underserved audiences in learning about materials science research. We are now transferring these experienced-based insights to new projects with other underserved audiences and believe they can be used in developing outreach projects with a wide variety of groups. Our insights and specific examples from our work are described below.

### *Build a Partnership*

Collaborating with people who regularly interact with the audience you are trying to reach is an effective and efficient way to ensure that your efforts are grounded in experience. It is also important to spend time and energy building trust and connection between your group and the people who are experts with the audience.

Even though MRSEC members were well intentioned in their desire to reach audiences that typically did not attend on-campus outreach events, we lacked both the access to and understanding of the people we wanted to impact. To gain these, we built partnerships with audience experts who worked with the target audiences and more importantly, understood their needs. The first step in bringing ISE to economically disadvantaged families was to develop a partnership with food pantry staff to understand both the audience and the environment. The MRSEC Education Director was a longtime volunteer at the pantry and she leveraged that relationship and trust to build the partnership. She also used her experience with the pantry environment to develop the outreach program. For example, she knew from experience that the pantry used a free choice food distribution model where clients selected their food as they would in a grocery store and that a challenge with this model is that clients often waited over an hour for service during busy times. The MRSEC used this existing wait time to lead materials science focused, ISE activities with clients in the waiting area (Fig).

### *Learn about the audience and environment*

Even if you have worked with a specific age group or in an environment previously, it is important to recognize that there may be important differences in

the specific group or the setting for a new outreach effort that may require adaptation of content or delivery.

Although the MRSEC education team had years of outreach experience, there were unique challenges to leading outreach in this environment. Initially, the goal was to work with children while their families were waiting for service, but it quickly became clear that people of all ages were interested in the activities. Consequently, participants ranged from toddlers to senior citizens with widely varying experience with, and interest levels in STEM. In addition, because the wait times were so varied, outreach engagement times could range from a few minutes to over an hour. Finally, there was only a small physical area available for the activities and it was situated outside of a busy and often crowded waiting room. Through trial and error and in collaboration with other outreach experts and pantry staff, the team found activities that were safe and engaging for a wide range of ages and experience levels, that had extensions for longer engagement, and that could be done in a small space without creating a mess or safety hazard for others in the waiting area.

### *Be flexible and adapt to partners' needs*

Audience experts you build partnerships with will likely have different needs, procedures, institutional norms, and goals than you do, and these can, and likely will, change over time. The partnership will be stronger if you are attentive to their changing needs and work to help them achieve their goals. Regular communication with your partners helps ensure that you understand the environment and audience over time.

In March 2020, COVID-19 forced our food pantry partners to rapidly shift from in-person to drive through, no-contact food distribution. Since this effectively ended the science outreach at the pantry project, the MRSEC members worked with the pantry staff to develop a new method for engaging clients with ISE. The MRSEC created science activity kits with both written and video instructions and began distributing them to clients during food pick-up (Fig).

To evaluate the project, we used a multi-modal approach to look at various aspects of the kits and their distribution. The kits' scientific content was evaluated by MRSEC researchers and age-matched audiences that were accessible during the pandemic lockdown (e.g., family members, including children of MRSEC members). The MRSEC's external evaluator led a virtual focus group with pantry staff and volunteers who were helping to distribute the kits. Evaluation data led to changes to the kits themselves such as including written instructions in both English and Spanish, and including even common household items such as aluminum foil and tape to make the kits more widely accessible. Because we were working with a vulnerable population and had limited in-person contact due to the method of food distribution, the Center was unable to evaluate the impact of the kits directly with the recipients. Instead, we used an observation protocol during kit distribution to evaluate whether the clients accepted a kit, how many they wanted, and record any comments they made when receiving the kit. To date, the MRSEC has developed 4 different kits with activities to: build a triboelectric generator, create art using polarizers, explore the properties of magnets, and play a game demonstrating how computers work; Center staff have distributed >1200 kits to clients at the pantry.

Due to the overwhelming positive response to the activity kits by recipients, pantry staff and volunteers, additional local pantries were added to the project and the development of new kits is ongoing. Distribution was also expanded beyond the pantry to include community centers, libraries, and homeless shelters.

#### *New partnerships to reach new audiences*

Regardless of how successful an outreach effort is, when you are ready to engage with a new audience, it is crucial to develop a new partnership with experts and adapt your efforts to the needs of the new audience. Due to the MRSEC's success building partnerships with experts to engage community members who are economically disadvantaged, the Center used this model to engage two new underserved audiences with ISE: people who are blind or low vision and students in migrant communities.

To engage with people who are blind or low vision, we began a partnership with the Wisconsin Council of the Blind and Visually Impaired (WCBlind) by first meeting with the leadership of the Council, who then connected MRSEC members with teachers in Madison who work with blind and low vision students. The MRSEC is currently working with the teachers and their students to develop materials-focused outreach activities that are accessible for audiences with low vision. In exchange for their expertise, the MRSEC is providing supplies and resources to the students and teachers. The MRSEC Education team also provided funding for the Director of the WCBlind and her colleagues to lead a workshop for MRSEC members on how to make their research and classroom presentations, outreach activities, and workspaces more accessible for people who have limited vision. External evaluation of the workshop demonstrated that most attendees found the workshop effective in helping them make their work more accessible. For example: 57% of respondents felt somewhat confident and 43% felt extremely or very confident that they could lead outreach activities in a more accessible way, 73% felt extremely or very confident that they could make their conference talks more accessible, 62% felt extremely or very confident that they could make their class lecture more accessible, and 79% felt extremely or very confident that they could make their group meetings more accessible (n=22 respondents). This project is ongoing and the MRSEC will continue to work with these partners to continue learning more strategies for making both formal and informal science communication more accessible for audiences with impaired vision.

Migratory students have more impactful interruptions to their education compared to their non-migratory peers and "their transience creates dislocation, disorientation and significant educational disadvantages" (Brantz-Spall 2003). According to a Wisconsin Department of Workforce Development report, in 2021, Wisconsin had over 7,000 reported migrant farmworker families. Working closely with Wisconsin state and regional Migrant Education Program (WI MEP) staff and educational advocates, the UW MRSEC assistant education director coordinated programming to reach some of Wisconsin's most vulnerable students, which was modeled off of previous STEM outreach programming she had developed for migrant high school students in Colorado. WI MEP program coordinators educated the MRSEC about the specific needs of migrant families in the state including understanding their work contract schedules, housing circumstances, and student

demographics. Through months of regular meetings, MRSEC members collaborated with WI MEP to develop a program designed to expose students to STEM fields and STEM practitioners at UW-Madison.

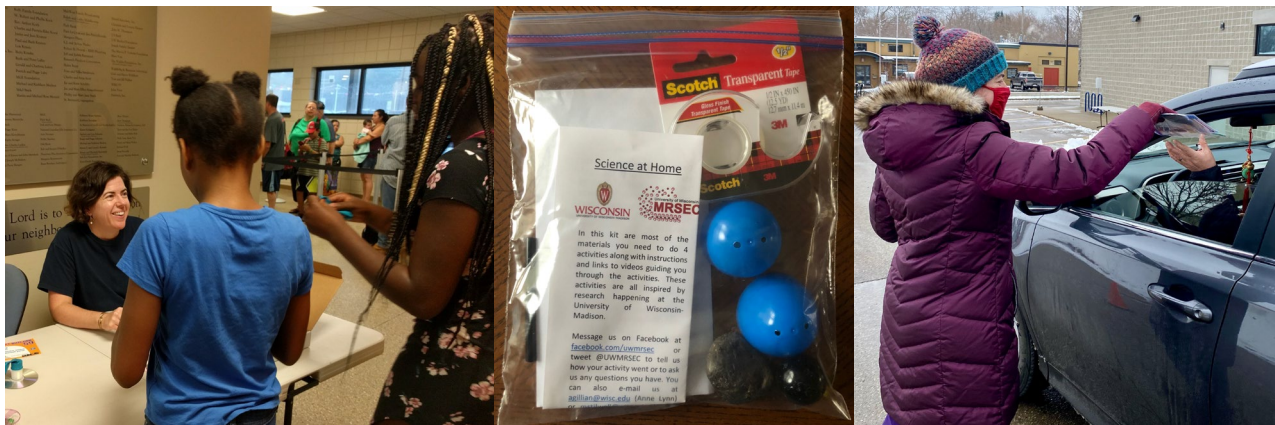
While remaining sensitive to the needs of this extremely vulnerable population, in July 2023, the MRSEC successfully hosted the inaugural Wisconsin Migrant Education Program STEM Day on the UW-Madison campus. Students from across Southern Wisconsin were transported by vans and buses provided by school districts and the state to campus where they visited several research laboratories in and beyond the MRSEC. Students also had the opportunity to learn about campus financial aid and admissions resources. Because most of the students are from Spanish-speaking families, the lab activities were primarily developed and presented in Spanish by LatinX scientists and UW staff who also served as role models for the students.

Because the Assistant Education Director in the MRSEC had worked with migrant populations previously and because the program was developed in collaboration with audience experts, it also included items not typically found in day-long STEM programs. For example, many of the students left campus at 4:00 pm with a 3+ hour bus ride home so in addition to lunch, they were also provided a box dinner for the trip home. The challenge of working with this population was further demonstrated by the attrition rate – many eligible students had to work with their parents, care for younger family members or were not present for pick-up at housing camps. The MRSEC will continue working with both state and local partners to expand this program into a longer experience for more students across the state. Representation matters (10) (11) and campus lab teams are enthusiastic about providing ongoing support for this work. Future projects also include visiting migrant communities and providing educational kits for students to take home and share with their families.

### *Lessons learned lead to improved understanding*

Through these experiences the MRSEC has learned the importance of collaboration with audience experts to understand the unique needs of the populations that we are trying to reach. As described, each audience we are working to engage has different needs and faces different challenges, which requires flexibility and adaptability when developing outreach programs and activities for those programs. The MRSEC's targeted outreach efforts have more impact and are more effective due to investments in creating connections with partners, increasing our awareness about the audience members' situations, and understanding all stakeholder's unique needs. Although the Center has experienced challenges unique to the various audiences it is serving, addressing these challenges is easier and more effective when there are experts to help guide the development of outreach programs. In turn, MRSEC members have gained significant experience with and understanding of the needs of diverse audiences, which has improved their ability to communicate and work with a greater diversity of people in both formal and informal education settings.

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**Fig. 1 Science at the Food Pantry Project. (left) A MRSEC member leads science outreach activities with pantry clients as they wait for service. (middle) Free, inclusive science activity kit the MRSEC developed to distribute during the pandemic. (right) A MRSEC member hands out free science activity kits during drive-through, no-contact food distribution.**



**Fig. 2 Workshop on working with audiences who are Blind/Low Vision. During the interactive part of the workshop, MRSEC members learned about tools that can help people with vision impairments (left and middle) and experienced what everyday tasks are like with a visual impairment (left). Center members used this experience to improve their outreach activities, scientific presentations, and communications.**





1. P. Bell, B. Lewenstein, A. W. Shouse, M. A. Feder, *Learning Science in Informal Environments: People, Places, and Pursuits*. N. R. C. o. t. N. A. Committee on Learning Science in Informal Environments, Ed., (The National Academies Press, Washington, DC, 2009).
2. J. H. Falk, L. D. Dierking, The 95 Percent Solution. *American Scientist* **98**, (2010).
3. J. H. Falk, M. Storksdieck, L. D. Dierking, Investigating public science interest and understanding: evidence for the importance of free-choice learning. *Public Understanding of Science* **16**, 455-469 (2007).
4. K. P. Dabney *et al.*, Out-of-School Time Science Activities and Their Association with Career Interest in STEM. *International Journal of Science Education, Part B: Communication and Public Engagement* **2**, 63-79.
5. A. V. Maltese, R. H. Tai, Eyeballs in the Fridge: Sources of early interest in science. *Int J Sci Educ* **32**, 669-685 (2010).
6. R. H. Tai, C. Q. Liu, A. V. Maltese, X. T. Fan, Planning early for careers in science. *Science* **312**, 1143-1144 (2006).
7. E. Dawson, "Not Designed for Us": How Science Museums and Science Centers Socially Exclude Low-Income, Minority Ethnic Groups. *Sci Educ* **98**, 981-1008 (2014).
8. L. Hinojosa, E. Swisher, N. Garneau, The organization of informal pathways into STEM: designing towards equity. *Int J Sci Educ* **43**, 737-759 (2021).
9. U. S. C. Bureau, U. D. o. Commerce, Ed. (USA.gov, 2022), vol. 2023.
10. B. E. Rincón, 19(4), 437–451. <https://doi.org/10.1177/1538192718820532>, Does Latinx Representation Matter for Latinx Student Retention in STEM? . *Journal of Hispanic Higher Education* **19**, 437–451 (2020).

11. G. Crisp, A. Nora, "Overview of Hispanics in Science, Mathematics, Engineering and Technology (STEM): K-16 Representation, Preparation and Participation," (Hispanic Association of Colleges and Universities, 2012).