Eyes on the Future: Inspiring Latino Middle School Youth to Pursue Careers in STEM Through Early Interactive Science Programming

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ABSTRACT

Background: Given the need for a diverse health care workforce, efforts must be made early in their education to support underrepresented minorities in medicine and the science, technology, engineering, and mathematics (STEM) fields.

Methods: The Eyes on the Future program introduces underrepresented minority 8th grade students to science and medicine via interactive science-based programming and mentorship by medical and graduate students. Program impact was evaluated using pre- and post-program surveys.

Results: Of 25 participating students, 24 and 22 responded to pre- and post-program surveys, respectively. Students showed strong interest in science concepts and STEM careers, with high, positively correlated, and statistically similar pre- and post-program survey responses.

Discussion: The Eyes on the Future program was well-received and represents a step towards addressing barriers to STEM careers faced by underrepresented minority students.

BACKGROUND

Given the racial and ethnic makeup of the United States and health disparities present, the need for a diverse health care workforce is imperative.[1] Physicians from groups underrepresented in medicine play an important role in caring for underserved populations and may be key to addressing health disparities. In 2020, Hispanic and Latino individuals made up 18.7% of the US population but in 2018 only accounted for 5% of the physician workforce and 6.2% of medical school matriculants.[2,3] Similarly, stark gaps can be found across other underrepresented minority (URM) racial and ethnic groups.

To create a more diverse health care workforce, efforts are needed to support URM students in medicine and the science, technology, engineering, and mathematics (STEM) fields early in their education. Although URM teens express interest in STEM careers at the same rate as White teens, URM students face a range of barriers while navigating a path to medicine, including cost, lack of guidance and role models, and challenges with professional identity development.[4-7] Professional identity development—ie, the process that teaches individuals how to think, act, and feel like a professional in the STEM fields—can be especially challenging for URM students who are learning how to navigate their intersectional identities.[5-6] Furthermore, a student's perceived enjoyment in the sciences—across all races—significantly decreases between the 4th and 8th grades, which suggests a critical timepoint to engage students in STEM.[4]

In this report, we describe the structure and content of the Eyes on the Future (EOTF) program, an early, interactive, science-based program implemented in a single school in Milwaukee, Wisconsin. We provide a preliminary assessment of its impact in influencing student attitudes about science and STEM careers and discuss its value to both middle school students and medical and graduate students, as well as suggestions for future directions. We hope the information from this study will be utilized to expand such programs for URM students in Wisconsin and beyond.

METHODS

EOTF Curriculum: Development, Goals, and Content

The EOTF program has been held yearly since 2014 and supports 25 students at a single school in Milwaukee, Wisconsin. In 2014, the Association of American Medical Colleges Diversity Policy and Programs unit held a ProjectMED video competition, which called

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for initiatives targeting K-12 students to increase the diversity of future physicians and scientists. The initial EOTF team submitted a video detailing the program and was awarded seed funding to support the program. The program aims to introduce URM 8th grade students, primarily of Latino background, to science and medicine via interactive science-based programming and mentorship by Medical College of Wisconsin (MCW) medical and graduate students. A key component to the success and continuity of this program has been the ongoing partnership between middle school staff, the MCW Department of Ophthalmology and Visual Sciences, and MCW's Latino Medical Student Association chapter.

This report focuses on the 2022 program, which consisted of 5 events: (1) an interactive presentation on eye anatomy and eye health conditions and creation of human eye models (Appendix 1); (2) cow eye dissections; (3) a medical simulation experience at the MCW Standardized Teaching Assessment Resource Center, where students listened to heart and lung sounds and practiced on a patient model who was a smoker with chronic obstructive pulmonary disease; (4) a visit to the Discovery World Science and Technology Museum; and (5) an information session on STEM careers, MCW pipeline programs, and preparation for graduate education. Students were selected for participation based on the science teacher's perception of the student's high baseline science interests. A focus on eye anatomy and health was chosen given that the US Hispanic and Latino population has some of the highest rates of vision loss and blindness caused by eye diseases, in addition to the existing collaboration with the MCW Department of Ophthalmology and Visual Sciences.[8]

Assessment and Evaluation Methods

Students completed a voluntary, anonymous survey before and after the EOTF program using the online Qualtrics survey tool. The survey was developed using questions adapted from previously published surveys.[9,10] Parents and students participating received an informational letter before the program and could choose to opt out of data collection. Questions focused on assessing student attitudes about the sciences and future career goals using a 5-point Likert scale (Appendix 2). Higher scores indicated more positive attitudes, except for the question "Boys generally do better in the sciences than girls," where higher values indicated agreement with the statement.

Data analyses were performed using R, version 4.1.0 (R Foundation). Responses to Likert-scale survey questions were analyzed within and across gender and question domain categories. Median ranks for each question were compared using the Mann-Whitney U test. Dependent *t* tests were used to compare mean pre- and post-program responses for question pairs. Cronbach's alpha reliability coefficients were calculated, with 95% confidence intervals determined by the Feldt method. A threshold of 0.7 was selected to indicate reliability. Spearman correlation coefficients were used for correlative analysis of pre- and post-program responses. Statistical significance was defined as $P < 0.05$. The MCW Institutional Review Board approved the study of this program.

Table 1. Demographics of Middle School Students

Variables	Pre-Program Count (N = 24)	Post-Program Count (N = 22)
Sex		
Boys	13 (54%)	12 (55%)
Girls	11 (46%)	10 (45%)
Race and Ethnicity[a]		
Hispanic or Latino/a	24 (100%)	22 (100%)
White	3 (13%)	3 (14%)
I plan to attend _____ after high school		
4-year college	20 (83%)	16 (73%)
2-year college	1 (4%)	1 (5%)
Technical school, apprenticeship, or trade school	0 (0%)	0 (0%)
Get a full-time job	0 (0%)	1 (5%)
Not sure	3 (13%)	4 (18%)

[a]Some students identified with more than one race or ethnicity category.

RESULTS

Twenty-five students participated in the 2022 program. Of these, 24 (96%; 13 boys, 11 girls) completed the pre-program survey and 22 (88%; 12 boys, 10 girls) completed the post-program survey. Student demographics are shown in Table 1. All respondents identified as Hispanic or Latino/a, and 3 respondents in both the pre- and post-surveys also identified as White. Students attended, on average, 4.7 of 5 events.

Pre- and post-program survey responses to questions in the science interest and STEM career domains were high for both boys and girls. Responses were above neutral for every question (Tables 2 and 3).

Comparison of pre- and post-program responses to individual questions using the Mann-Whitney U test revealed a statistically significant decrease in the median score for boys answering, "I like hearing science presentations." None of the remaining comparisons were statistically significant for any combination of gender and question domain (Table 3).

Comparison of average Likert scores between pre- and post-program responses with the dependent *t* test revealed no statistically significant differences for any combination of gender and question domain (Table 3).

Cronbach's alpha reliability coefficients were generally high. However, confidence intervals overlapped the threshold of 0.7 for every combination of gender and question domain (Appendix 3).

Correlative analysis of average Likert scores for each question showed a strong, positive correlation between pre- and post-program scores. Spearman correlation coefficients were statistically significant for every combination of gender and question domain (Appendix 4).

Table 2. Results of Science Attitudes Questions – Counts and Percentages

	Total		Boys		Girls	
Science Interest Questions[a]	**Pre-Program (N = 24)**	**Post-Program (N = 22)**	**Pre-Program (N = 13)**	**Post-Program (N = 12)**	**Pre-Program (N = 11)**	**Post-Program (N = 10)**
Science is interesting.	23 (96%)	21 (95%)	13 (100%)	12 (100%)	10 (91%)	9 (90%)
I like hearing science presentations.	19 (79%)	13 (59%)	11 (85%)	7 (58%)	8 (73%)	6 (60%)
I like talking about science with others.	15 (63%)	15 (68%)	10 (77%)	8 (67%)	5 (45%)	7 (70%)
I like asking questions.	12 (50%)	11 (52%)	6 (46%)	6 (50%)	6 (55%)	5 (50%)
I want to take more classes in science.	22 (92%)	18 (82%)	13 (100%)	9 (75%)	9 (82%)	9 (90%)
I understand science.	17 (71%)	17 (77%)	12 (92%)	10 (83%)	5 (45%)	7 (70%)
I feel I will get a good grade in science.	22 (92%)	21 (95%)	13 (100%)	12 (100%)	9 (82%)	9 (90%)
Science is useful to the world.	24 (100%)	22 (100%)	13 (100%)	12 (100%)	11 (100%)	10 (100%)
Science will affect me throughout my life.	23 (96%)	21 (95%)	12 (92%)	11 (92%)	11 (100%)	10 (100%)
STEM Career Questions[a]	**(N = 24)**	**(N = 22)**	**(N = 13)**	**(N = 12)**	**(N = 11)**	**(N = 10)**
I want to have a job in science and medicine in the future.	19 (79%)	17 (77%)	9 (69%)	9 (75%)	10 (91%)	8 (80%)
I am smart enough to pursue a job in science and medicine.	19 (79%)	19 (86%)	10 (77%)	11 (92%)	9 (82%)	8 (80%)
A job in science and medicine is cool.	24 (100%)	21 (95%)	13 (100%)	11 (92%)	11 (100%)	10 (100%)
Anyone can have a job in science and medicine.	19 (79%)	18 (82%)	10 (77%)	10 (83%)	9 (82%)	8 (80%)
Going to college is very important to me.	23 (96%)	20 (91%)	13 (100%)	11 (92%)	10 (91%)	9 (90%)
Going to college is very important to my family.	24 (100%)	21 (95%)	13 (100%)	11 (92%)	11 (100%)	10 (100%)
I feel like I will have adequate resources and support to apply to college in the future.	22 (92%)	22 (100%)	12 (92%)	12 (100%)	10 (91%)	10 (100%)

Abbreviation: STEM, science, technology, engineering, and mathematics.

[a]Likert scale response options: Strongly disagree (1 point), disagree (2 points), neither agree nor disagree (3 points), agree (4 points), strongly agree (5 points). The values are given as the number of respondents who responded with "agree" (4 points) or "strongly agree" (5 points) on the 5-point Likert scale, with the percentage in parentheses.

When asked about level of agreement with the statement, "Boys generally do better in the sciences than girls," 67% of students disagreed or strongly disagreed before the program, while 77% disagreed after the program. No students agreed or strongly agreed with this statement at either time point (Appendix 5).

DISCUSSION

This report describes an early science-based program for URM students in the 8th grade and provides a preliminary assessment on influencing student attitudes about science and STEM careers. Overall, the program exposed students to a variety of STEM careers, provided information on pipeline programs, connected participants with local medical and graduate school contacts, increased their knowledge on eye health conditions, and encouraged professional identity development. Additional benefits included providing medical and graduate students an opportunity to give back to the local community and to develop communication skills. The development of such skills is essential for future physicians and scientists as they educate the public and disseminate information.[9]

Unique features of the EOTF program include the strong partnership with the middle school and leadership from the Latino Medical Student Association, which promoted student mentorship. Priority was placed on recruiting a diverse group of MCW student volunteers to share their experiences navigating their academic journey, including the challenges they faced along the way, and to model URM student professional identity development. These mentors also taught students about eye and health conditions affecting the Latino community, hopefully enabling them to raise awareness and become early health advocates within their families and community. Furthermore, many middle school students were introduced to local medical and science institutions, such as the Medical College of Wisconsin and the Discovery World Science and Technology Museum.

Despite students' subjectively positive response to the program, statistical analyses of Likert survey data were generally equivocal. In univariate comparison of mean pre- and post-program survey scores, the only statistically significant difference was a decrease in boys' response to "I like hearing science presentations." This finding may represent either a true decrease in boys' interest in hearing science presentations or a false-positive error in the setting of multiple comparisons. Pairwise comparisons within and across question domains revealed no statistically significant differences. Wide confidence intervals for Cronbach's alpha reliability coefficients suggested that modifications to survey design or sample size may result in a more reliable measure of attitudes. Finally, pre- and post-program survey scores showed a strong positive correlation, indicating that students' positive attitudes before the EOTF program were maintained afterward.

The rationale for these equivocal changes pre- and post-

Table 3. Results of Science Attitudes Questions – Averages and *P* values

	Total			Boys			Girls		
	Pre-Program Avg (N = 24)	Post-Program Avg (N = 22)	*P* value	Pre-Program Avg (N = 13)	Post-Program Avg (N = 12)	*P* value	Pre-Program Avg (N = 11)	Post-Program Avg (N = 10)	*P* value
Science Interest Questions[a]									
Science is interesting.	4.29	4.23	0.95[b]	4.54	4.42	0.70[b]	4.00	4.00	0.42[b]
I like hearing science presentations.	4.08	3.73	0.10[b]	4.38	3.67	0.03[b]	3.73	3.80	>0.99[b]
I like talking about science with others.	3.63	3.73	0.65[b]	3.85	3.75	0.70[b]	3.36	3.70	0.32[b]
I like asking questions.	3.46	3.62	0.69[b]	3.46	3.64	0.64[b]	3.45	3.60	0.95[b]
I want to take more classes in science.	4.17	3.95	0.28[b]	4.38	4.00	0.21[b]	3.91	3.90	>0.99[b]
I understand science.	3.79	3.86	0.73[b]	4.15	4.00	0.71[b]	3.36	3.70	0.27[b]
I feel I will get a good grade in science.	4.04	4.09	0.53[b]	4.23	4.17	>0.99[b]	3.82	4.00	0.39[b]
Science is useful to the world.	4.79	4.82	>0.99[b]	4.77	4.92	0.59[b]	4.82	4.70	0.64[b]
Science will affect me throughout my life.	4.38	4.41	0.90[b]	4.38	4.42	>0.99[b]	4.36	4.40	>0.99[b]
Average Score	4.07	4.05	0.71[c]	4.24	4.11	0.20[c]	3.87	3.98	0.07[c]
STEM Career Questions[a]									
I want to have a job in science and medicine in the future.	4.17	4.18	>0.99[b]	4.15	4.25	>0.99[b]	4.18	4.10	0.99[b]
I am smart enough to pursue a job in science and medicine.	4.00	3.86	0.33[b]	4.15	4.00	0.46[b]	3.82	3.70	0.59[b]
A job in science and medicine is cool.	4.33	4.36	0.76[b]	4.38	4.42	0.85[b]	4.27	4.30	>0.99[b]
Anyone can have a job in science and medicine.	4.29	4.27	0.77[b]	4.15	4.25	>0.99[b]	4.45	4.30	0.73[b]
Going to college is very important to me.	4.75	4.59	0.44[b]	4.85	4.67	0.52[b]	4.64	4.50	0.71[b]
Going to college is very important to my family.	4.83	4.68	0.41[b]	4.77	4.83	0.59[b]	4.91	4.50	0.064[b]
I feel like I will have adequate resources and support to apply to college in the future.	4.29	4.36	0.84[b]	4.38	4.33	0.85[b]	4.18	4.40	0.53[b]
Average Score	4.38	4.33	0.21[c]	4.40	4.39	0.80[c]	4.35	4.26	0.25[c]

Abbreviation: STEM, science, technology, engineering, and mathematics.

[a]Likert scale response options: Strongly disagree (1 point), disagree (2 points), neither agree nor disagree (3 points), agree (4 points), strongly agree (5 points).

[b]Mann-Whitney test.

[c]Paired *t* test.

program is likely multifactorial but primarily related to study power. Students selected to participate in the program already had a positive attitude toward science. Therefore, the expected effect size was smaller, and more participants would be needed to appreciate differences with statistical significance. Alternatively, enrolling students with a lower baseline interest in science could leave greater room for improvement in response to the program, which might be measurable without a drastic increase in the number of participants. Finally, revisions to the survey may help evaluate student attitudes with greater precision, leading to a more powerful study.

In the future, we hope to increase our sample size and outreach by broadening inclusion criteria. Meanwhile, adding unique, anonymized survey codes would enable pairwise comparison of individual participants. Long-term goals include tracking longitudinal impact on career choice and utilizing focus groups to collect qualitative data on student attitudes toward the program.

Substantial systemic changes are needed to address the barriers faced by URM students interested in science and STEM careers. The EOTF program is one example of how community outreach can help children and adolescents confront some of these barriers through education and mentorship, support early professional identity development, and encourage a sense of inclusion and belonging for URM students in STEM. This early, low-cost outreach program also could be adapted for use in a variety of settings and populations.

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Appendices: Available at www.wmjonline.org.

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