



STEM Education Needs All Children:

A Critical Examination of Equity Issues

Resource Materials

**STEM EDUCATION
RESEARCH INSTITUTE**

INDIANA UNIVERSITY-PURDUE UNIVERSITY
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STEM Needs All Children

By 2018 a total of 8 million U.S. jobs will be in STEM related fields.

STEM plays a critical role in global innovations and advancements. It is therefore important to have a diverse and representative STEM workforce.

Advocating for equitable K-12 STEM education today helps to ensure adequate representation of all groups in future STEM careers.

Culturally Responsive STEM Teaching and Learning Pays Attention to:

Identity

Situating students' cultural and personal identities as competent learners in STEM activities

Responsiveness

Utilizing various methods to maximize students' opportunities to learn STEM concept and literacies

Empowers students to use STEM as tools for understanding their world and solving community and global problems

Agency

Relevance

Connecting STEM concepts to students' lived experiences and bridging their funds of knowledge to new learning

STEM Educational Equity Analysis Tool



Purpose:

Self-assessment tools offer an opportunity to pause and critically reflect on policies and practices; this tool in particular invites schools into a self-evaluation of equity in STEM teaching and learning, with an eye toward graduating students who are prepared for and excited about engaging in STEM careers.

Instructions:

1. Assemble group that includes representation from all school stakeholders (leadership, staff, families, students, and community partners)
2. Discuss each area in the rubric and mark your school as “Not Evident,” “Beginning,” “Developing,” or “Mature.”
3. Add criteria as needed to develop a full picture of STEM educational equity at your site.
4. Select a few areas for further inquiry. What information do you need to better assess the school’s current status?
5. Select a few areas for growth. What strategies will you use to improve?

ORGANIZATIONAL CAPACITY	Not Evident	Beginning	Developing	Mature	NOTES
Leadership					
Building leaders demonstrate a commitment to building organizational capacity in STEM.					
Building leaders regularly demonstrate a commitment to equity in STEM education.					
Leaders provide specific feedback to staff based on best practices in culturally responsive teaching and effective STEM instructional strategies.					
Staffing					
Counselor-to-student ratio is sufficiently low to allow for individualized attention.					
STEM teachers represent the diversity of the community they					
STEM teachers are highly qualified in their content areas.					
STEM teachers are trained in highly engaging STEM pedagogical practices.					
Sufficient technological support is available to staff and students.					
Professional Learning					
Hands-on opportunities to learn are provided to teachers.					
Collaborative inquiry is supported.					
Partnerships					
Families are engaged in activities and learning about STEM subjects and careers.					
Families are provided information about out-of-school opportunities related to STEM.					
Community organizations are engaged to provide materials, experiences, and human capital.					

STEM Educational Equity Analysis Tool



CURRICULUM & INSTRUCTION	Not Evident	Beginning	Developing	Mature	NOTES
Rigor					
Highly qualified teachers are available to all students.					
Counselors encourage challenging course-taking.					
Students have EXPLICIT access to higher-level STEM courses.					
Courses align with local, state, and national standards in STEM education.					
Teachers hold high expectations for all students.					
All students achieve at high levels in STEM courses.					
Culturally Responsive Curriculum					
Curriculum is relevant to students' community and culture.					
Students see themselves represented in curricular materials.					
Materials are accessible.					
Materials promote active, inquiry-based learning.					
STEM and other disciplines are integrated.					
STEM curriculum is connected to local concerns and social justice issues.					
Culturally Responsive Instructional Practices					
Instructional methods inspire interest and engagement in STEM.					
The notion that abilities are expandable is regularly reinforced.					
Activities connect STEM concepts to learners' interests and experiences.					
Activities allow for hands-on learning.					
The teacher is a learner alongside the students.					
Opportunities for dialogue and problem-solving are frequent.					
Multiple means are used to support student learning.					
Assessments provide multiple means of demonstrating understanding.					
Efforts are made to engage underserved students.					
Assessment					
Students are provided multiple opportunities and means to demonstrate what they have learned.					
Specific feedback is given, with emphasis on effort and types of strategies used by students.					
Ongoing Engagement					
Co-curricular and extracurricular activities are made available to all.					
Underrepresented students are actively encouraged to join co-curricular and extracurricular activities.					
STEM work-based learning experiences are made available.					
Guest presenters and field experiences demonstrate that individuals from diverse backgrounds can achieve in STEM careers.					
Families are engaged as guest teachers about STEM subjects and careers.					
Guidance about postsecondary and career options includes STEM opportunities, particularly for underrepresented students.					

STEM Lesson Considerations



ELEMENTS OF EFFECTIVE STEM INSTRUCTION*	EQUITY CONSIDERATIONS
<i>INITIATING/SITUATING THE INQUIRY</i>	
Motivation	
<p><i>What do students <u>wonder about</u> or can they be induced to wonder about – <u>why are we doing this</u> and <u>why should I be interested</u>?</i></p> <ul style="list-style-type: none"> Focus questions Discrepant events Simple prediction making Connections to previous, relevant lessons 	<p>The motivation for inquiry should be grounded in <i>students' personal interests, local social and environmental concerns, and community values</i> (Freire, 2000).</p>
	<p>To effectively capitalize on student motivations, teachers need <i>deep understanding of students' and families' lived experiences</i>.</p>
	<p>Providing <i>role models who look like your students</i> may help motivate students (Institute of Education Sciences, 2007).</p>
	<p>Recognize that motivations may be different for different students, so multiple strategies and/or access points may be needed (Microsoft Corp, 2011).</p>
Surfacing Student Thinking	
<p><i>What do students <u>already know</u> or <u>think they know</u> about the investigation topic?</i></p> <ul style="list-style-type: none"> Elicit initial student thinking Discussion and documentation of initial thinking Make scientific/mathematical conjectures 	<p>Create a safe space for student engagement through a focus on positive school and classroom climate.</p>
	<p>Value students' initial thinking, with feedback focused on effort (Doing What Works, 2007).</p>
	<p>Encourage participation from all students by creating multiple opportunities and means of engaging in the conversation (CAST, Inc., 2012).</p>
	<p>Help students make explicit the evidence and reasoning they are already using (Lee, 2001).</p>
<i>ENGAGING THE INQUIRY</i>	
Intellectual Engagement	
<p><i>How are students engaged in <u>meaningful experiences</u> that develop <u>important concepts</u>?</i></p> <ul style="list-style-type: none"> Meaningful questions are posed Student-centered and -led investigative process Experiences support and are tied to learning goals Appropriate data, models, and phenomena are explored Students formulate new ideas and knowledge based on evidence and problem solving Key terms emerge as ideas develop and are defined in context of the inquiry 	<p>Create a safe space for student engagement through a focus on positive school and classroom climate.</p>
	<p>Explicitly teach students that abilities are expandable (Institute of Education Sciences, 2007)</p>
	<p>Emphasize the contributions of underrepresented individuals to stem fields (Pettway, 2013).</p>
	<p>Hold high expectations for all students, regardless of race, gender, national origin, ability or other characteristic.</p>

STEM Lesson Considerations



Engaging in Scientific/Mathematic Discourse	
<p><i>In what ways are students supported in <u>practicing the scientific/mathematic enterprise</u>?</i></p> <ul style="list-style-type: none"> Inquiry as a process of knowledge generation as oppose to rote memorization of already determined “facts” Support students’ conceptual understanding Documentation of process, questions, data, and findings Data used as evidence to communicate, make, and critique claims Students are supported in debating ideas and questions (e.g., class discussions, journals etc.) 	<p>Recognize that scientific discourse is not culturally neutral; it is a unique culture in and unto itself.</p> <p>In science classes, teachers have been observed to interact differently with boys and girls, encouraging boys to ask questions and explain concepts more. Reflect on implicit biases and ensure that you are providing equal opportunities to all students to inquire and discuss (AAUW, 2010).</p> <p>Create room for informal and native language use while building capacity for traditional science discourse (National Research Council, 2009).</p>
In-Process Meaning-Making	
<p><i>In what ways are students supported in <u>drawing important conclusions about their data and the targeted science/mathematics ideas</u>?</i></p> <ul style="list-style-type: none"> Skillful teacher questioning, facilitation, and explanations Make meaning about data and targeted ideas or concepts in the inquiry Communicate, analyze, and evaluate their thinking and thinking of others with peers, teachers, and others 	<p>Recognize that there are no neutral or cultureless perspectives; students will differ in what they deem relevant (National Research Council, 2009).</p> <p>Recognize multiple ways to create, interpret, prove, and represent mathematical arguments, ideas, models, and concepts (NCTM, 2000).</p> <p>Critically examine dominant ways of data collection, analysis, and presentation and who benefits from these.</p>
MAKING MEANING FROM THE INQUIRY	
Summative Meaning-Making	
<p><i>In what ways are students supported in <u>drawing important conclusions about their data and the targeted science/mathematics ideas</u>?</i></p> <ul style="list-style-type: none"> Reflect on initial thinking and how thinking has/not changed Expand and connect to broader and related concepts (inter- and intra-curricular) Apply to new or real-world contextualized scenarios 	<p>Engagement in STEM by underrepresented groups has the possibility of increasing attention to the concerns of these groups (National Research Council, 2009). Offer the opportunity to engage in activities linked to social and environmental justice concerns.</p> <p>Foreground and value what was learned from students and communities of different ways of doing/creating mathematics (Gutiérrez, 2010) and science.</p> <p>Examine how STEM practices relate to student identity, power, and as a part of larger society (Gutiérrez, 2010).</p>

*Derived from *Effective Science Instruction: What Does Research Tell Us?* (Banilower et al., 2008)

Examining Representation in Your Setting

Who do you see....

<u>In course materials?</u>	
In advanced vs. remedial courses?	
<u>In posters, pictures, fliers?</u>	
<u>Teaching classes?</u>	
<u>Guest lecturing?</u>	
<u>On field trips?</u>	
In extracurricular Activities?	



Resources within Region V

Description		Website	Contact Information
Illinois			
<i>Change the Equation Data Sheet:</i> http://www9.georgetown.edu/grad/gppi/hpi/cew/pdfs/stemillinois1.pdf			
I-STEM Education Initiative	The I-STEM Initiative brings internal and external partners together to facilitate P-16 education outreach, improve teacher training, foster reform in higher education, and shape policy and advocacy.	http://www.istem.illinois.edu/	704 South Sixth St Champaign, IL 61820 217-333-9625 i-stem@illinois.edu
Illinois Pathways	This state-led initiative is designed to bolster college and career readiness through learning exchanges and supports for local programs.	http://www.illinoisworknet.com/vos_portal/STEM/en/Home/	ContactUs.htm">http://www.illinoisworknet.com/vos_portal/STEM/en/About/page>ContactUs.htm
Indiana			
<i>Change the Equation Data Sheet:</i> http://www9.georgetown.edu/grad/gppi/hpi/cew/pdfs/stemindiana1.pdf			
STEM Education Research Institute	SERI promotes and coordinates research on learning in STEM.	http://seri.iupui.edu/index.php	755 W. Michigan St Indianapolis, IN 46202 seri@iupui.edu
Urban Center for the Advancement of STEM	UCASE increases the numbers of highly qualified STEM teachers through program development, STEM education research, and scholarships.	http://www.iupui.edu/~ucase/	902 W New York St., ES 1115 Indianapolis, IN 46202 317-278-6778
I-STEM Resource Network	I-STEM is a collaborative of public and private entities that designs and employs programs to address STEM issues.	https://www.istemnetwork.org/	203 Martin Jischke Dr West Lafayette, IN 47907 765-494-2757 istem@istemnetwork.org
Techpoint Foundation for Youth	Techpoint incubates STEM programs that have the potential for student impact.	http://techpointyouth.org/	615 N Alabama St, Suite 119 Indianapolis, IN 46204 317-634-2423 info@techpointfoundation.org
Michigan			
<i>Change the Equation Data Sheet:</i> http://www9.georgetown.edu/grad/gppi/hpi/cew/pdfs/stemmichigan1.pdf			
Michigan STEM Partnership	This statewide collaborative is dedicated to elevating STEM literacy and proficiencies.	http://mistempartnership.com/	517-899-4233 info@mistempartnership.com
STEM Alliance of Michigan	SAM connects teachers and caregivers to experts in STEM education.	http://www.stemmi.org/	248-239-0284 roseann@nicolaievents.com
Michigan Mathematics and Science Centers Network	This network of 33 regional centers elevates mathematics and science education for students in Michigan.	http://www.mimathandscience.org/	734-418-1479 lecasler69@gmail.com



Resources in Region V (continued)

Description		Website	Contact Information
Minnesota			
<i>Change the Equation Data Sheet:</i> http://www9.georgetown.edu/grad/gppi/hpi/cew/pdfs/stemminnesota1.pdf			
MN-STEM	This initiative is directed toward engaging high school students, their parents, and educators in demanding courses and postsecondary planning.	http://www.mn-stem.com/	651-582-8200 Mde.stem@state.mn.us
Minnesota STEM Network	SciMathMN is a coalition advocating for high-quality STEM education.	http://www.scimathmn.org/mnstemnet.htm	130 Humphrey School 301 19th Ave. S Minneapolis, MN 55455 info@scimathmn.org
Ohio			
<i>Change the Equation Data Sheet:</i> http://www9.georgetown.edu/grad/gppi/hpi/cew/pdfs/stemohio1.pdf			
Ohio STEM Learning Network	OSLN is a network that connects existing STEM schools and programs to spread effective practices and tools.	http://www.osln.org/	333 W. Broad St. Columbus, OH 43215 1-800-201-2011 OSLN@battelle.org
Ohio's STEM Ability Alliance	This alliance is focused on increasing the number and quality of Ohio STEM graduates with dis-	http://nisonger.osu.edu/osaa/	3640 Colonel Glenn Highway Dayton, OH 45435
Wisconsin			
<i>Change the Equation Data Sheet:</i> http://www9.georgetown.edu/grad/gppi/hpi/cew/pdfs/stemwisconsin1.pdf			
Milwaukee Mathematics Partnership	A collaborative of various educational, government, community, and business organizations to improve math achievement for Milwaukee Public Schools students	http://www4.uwm.edu/Org/mmp/	Center for Mathematics and Science Education Research P.O. Box 413, Enderis 265 Milwaukee, WI 53201-0413
System-wide change for all learners and educators	A collaborative of mathematicians, scientists, social scientist, engineers, technologists, and education practitioners working to reform k-12 math and science education	http://scalemsp.wceruw.org/	System-wide Change for All Learners and Educators Wisconsin Center for Education Research 1025 W. Johnson St. Room 557 Madison, WI 53706 Phone: (608) 263-3605
WISTEM	Portal that houses resources for students and adults interested in pursuing STEM careers	http://wistem.org/	peggy.garties@ecb.org

Other Resources

Stem Education Coalition

- The STEM Education Coalition works to support programs for teachers and students
- <http://www.stemedcoalition.org>

Successful STEM Education

- Check here for STEM-related information, events, and resources.
- <http://successfulstemeducation.org>

The Algebra Project

- This non-profit uses mathematics instruction as a grassroots organizing tool to ensure quality public education.
- <http://www.algebra.org>

Women in STEM

- The White House Office of Science and Technology Policy provides resources and event listings related to women in STEM.
- <http://www.whitehouse.gov/administration/eop/ostp/women>

Change the Equation

- This non-profit mobilizes the business industry to support STEM through philanthropy, advocacy, and education.
- <http://changetheequation.org>

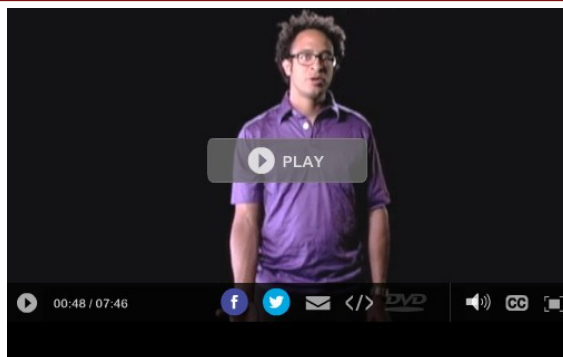
Hear One Man's Story

Activity:

View this video, "Becoming the Professor."

Questions:

- What supports and barriers surfaced?
- What are the implications for K-12 education?



<http://www.pbs.org/teachers/stem/>

Explore a Macro-level Initiative

Activity:

View this video from the National Action Council for Minorities in Engineering.

Questions:

- What systemic supports does this organization provide?
- How might similar supports be engaged in your own context?



<https://www.youtube.com/watch?v=kVNihlx3Rog>



About the Great Lakes Equity Center

The mission of the Great Lakes Equity Center is to ensure equity in student access to and participation in high quality, research-based education by expanding states' and school systems' capacity to provide robust, effective opportunities to learn for all students, regardless of and responsive to race, sex, and national origin, and to reduce disparities in educational outcomes among and between groups. The Equity by Design briefs series is intended to provide vital background information and action steps to support educators and other equity advocates as they work to create positive educational environments for all children. For more information, visit <http://www.greatlakesequitycenter.org>.

Disclaimer

Great Lakes Equity Center is committed to the sharing of information regarding issues of equity in education. The contents of this practitioner brief were developed under a grant from the U.S. Department of Education. However, these contents do not necessarily represent the policy of the Department of Education, and you should not assume endorsement by the federal government.