# STEM Learning and Research (STELAR) Center @ Education Development Center

## ITEST's STEM Workforce Education Model
## Thursday October 6, 2016

# Who We Are

- STEM Learning & Research Center (STELAR)

  - http://stelar.edc.org/

- Education Development Center

- Supporting the program and its grantees since 2003

- Available to assist those considering submitting an ITEST proposal

# What We Do

- Facilitate projects' success through **technical support** with a focus on synthesis of findings

- Inform and influence the field of STEM stakeholders by **disseminating** project findings nationally

- Deepen the impact and reach of the ITEST program by **broadening participation** in the ITEST portfolio

# Some of Our Activities

- **Webinars:** Effective Dissemination, Designing Research for ITEST Projects, Mentoring Models

- **Monthly Newsletter:** Information to stay updated on all things STEM and ITEST

- **Project Liaisons:** A STELAR staffer who works directly with each project to provide resources and make connections

- **Regional and Thematic Meetings:** A way for current projects to network with each other

- **Management Information System (MIS):** Annual collection of project information about what projects do, who they work with, what they have achieved

# Find Resources on STELAR Website

# Get Ideas for Designing ITEST Proposals

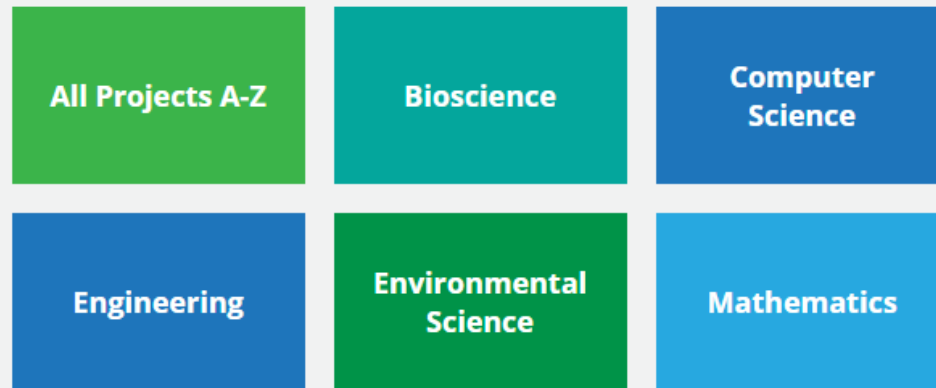ITEST Proposal Development: http://stelar.edc.org/proposal-development



- **+ GET TO KNOW ITEST**
- **+ PREPARE YOUR PROPOSAL FOR SUBMISSION**
- **+ DEVELOP A ROBUST RESEARCH DESIGN**
- **+ CREATE AN EFFECTIVE EVALUATION STRATEGY**
- **+ CONNECT WITH PARTNERS**
- **+ REACH UNDERSERVED POPULATIONS**
- **+ DEVELOP THE WORKFORCE OF THE FUTURE**

# Find Project Profiles

# Resource Library – Publications, Curricular Materials & Instruments

# Connect with others via the People Connector

http://stelar.edc.org/opportunities/people-connector-directory

People Connector Form

People Connector Directory

# STELAR is on Social Media – Stay in Touch!

**Contact us:** stelar@edc.org

**Facebook:** https://www.facebook.com/stelarctr

**Twitter:** https://twitter.com/STELAR_CTR

**LinkedIn:** https://www.linkedin.com/groups/STELAR-Center-4426955/about

**Find resources:** http://stelar.edc.org/

# Acknowledgement of Support

# STELAR Webinar: ITEST's STEM Workforce Education Model

**Presenters:**

**Joyce Malyn-Smith -** Managing Project Director at Education Development Center and Senior Advisor to the STELAR Center

**Kirk Knestis** –  CEO of Hezel Associates

http://www.hezel.com/

**David Reider** – Principal Partner of Education Design
www.educationdesign.biz

Joyce Malyn-Smith
Education Development Center, Inc.

# ITEST's Data and Impact Working Group

- What does STEM career/workforce development look like?
- What data should STEM programs be collecting to show their impact on STEM workforce development?

# ITEST's Guiding Questions:

1. What coherent sets of experiences effectively and efficiently support student competency (e.g. knowledge, skills), motivation and persistence for productive participation in the STEM-related workforce of today or in the future?

2. What instructional and curricular models can effectively engage teachers to utilize and integrate technologies so as to enhance student understanding of STEM-related occupations?

3. What roles might business and industry workforce members play in motivating students to become aware of, interested in, and prepared for careers in the STEM-related workforce?

4. What roles might business and industry play in preparing teachers to support student awareness of the workplace?

5. What strategies might parents, mentors and caregivers adopt in the digital and computer age that develop student understandings of and appreciation for the scientific, technical, mathematical, and engineering basis of technological developments?

6. What strategies effectively engage principals, guidance counselors, and other school system administrative leaders to promote student and teacher adoption and effective use of technologies that support STEM-related learning and career awareness?

7. Given the shifting demographics reflected in our current classrooms and in our country, what are effective and productive ways to ensure broadening participation by engaging diverse underrepresented populations in STEM programs and careers?

# Theoretical Foundations

Career Development

Social Cognitive

Social Constructionist

Developmental Contexualist

Exploration

# ITEST Workforce Education Helix



12-16

High School

7-9

K-6

STEM Content Development Activities

STEM Career Development Activities

Cultural Context

Partnerships
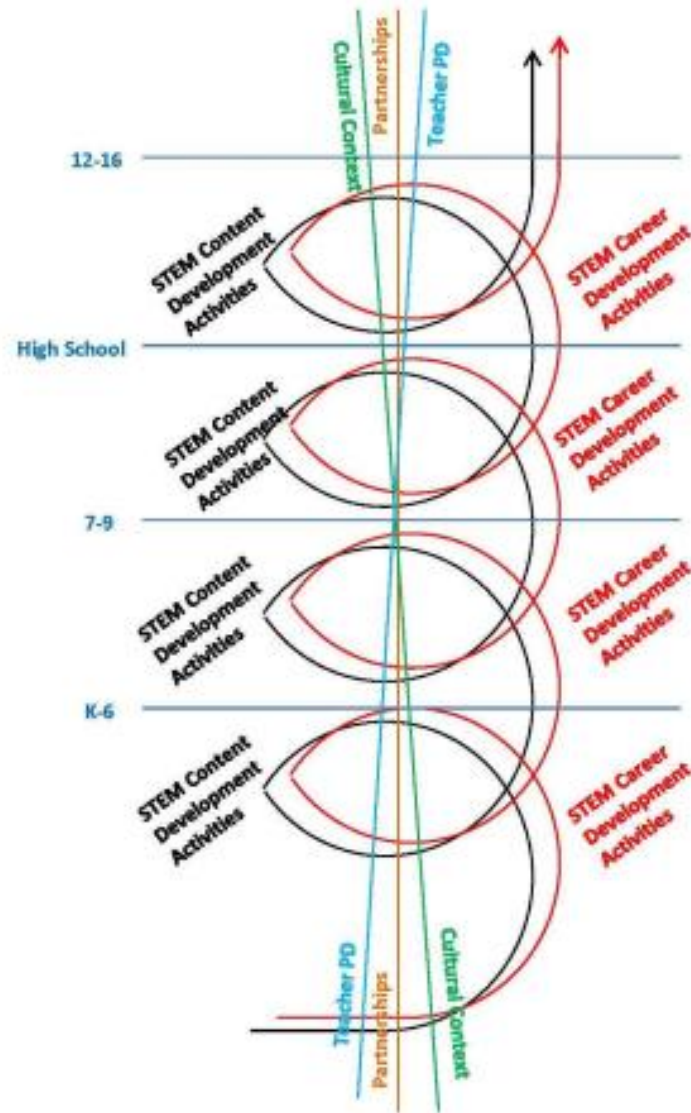
Teacher PD

**STEM Content Development Activities**
**STEM Career Development Activities**
**Teacher Professional Development**
**Partnerships**
**Cultural Context**

# Outcomes and Indicators

| STEM Content Outcomes | • Dispositions<br>• Knowledge<br>• Skills<br>• Actions |
|---|---|
| STEM Career Outcomes | • Dispositions<br>• Knowledge<br>• Skills<br>• Actions |

stelar
STEM Learning and Research Center

NSF

EDC Learning transforms lives.

# STEM Outcomes Matrix

|  | Dispositions | Knowledge | Skills | Actions |
|---|---|---|---|---|
| **STEM Content** | Interest in biology | Understanding of the nitrogen cycle | Ability to collect environmental data | Taking an elective life sciences course |
| **STEM Careers** | Belief that one can be a scientist | Familiarity with engineering disciplines | Ability to write a technical report | Engaging in an engineering internship |

# STELAR Webinar: ITEST's STEM Workforce Education Model

# Kirk Knestis, PhD

Hezel
ASSOCIATES

# About Logic Models

- Models are abstractions intended to serve a purpose
- In the context of ITEST, logic models…
  - Describe theories about "what causes intended outcomes" in the STEM career education pipeline
  - Illustrate relationships among factors (features of programs or innovations) and expected outcomes

# About Logic Models: Tabular Models

| | | OUTCOMES | | |
|---|---|---|---|---|
| **ACTIVITIES** | **OUTPUTS** | Short Term | Intermediate | Long Term |
| | | | | |

# About Logic Models: Path Models
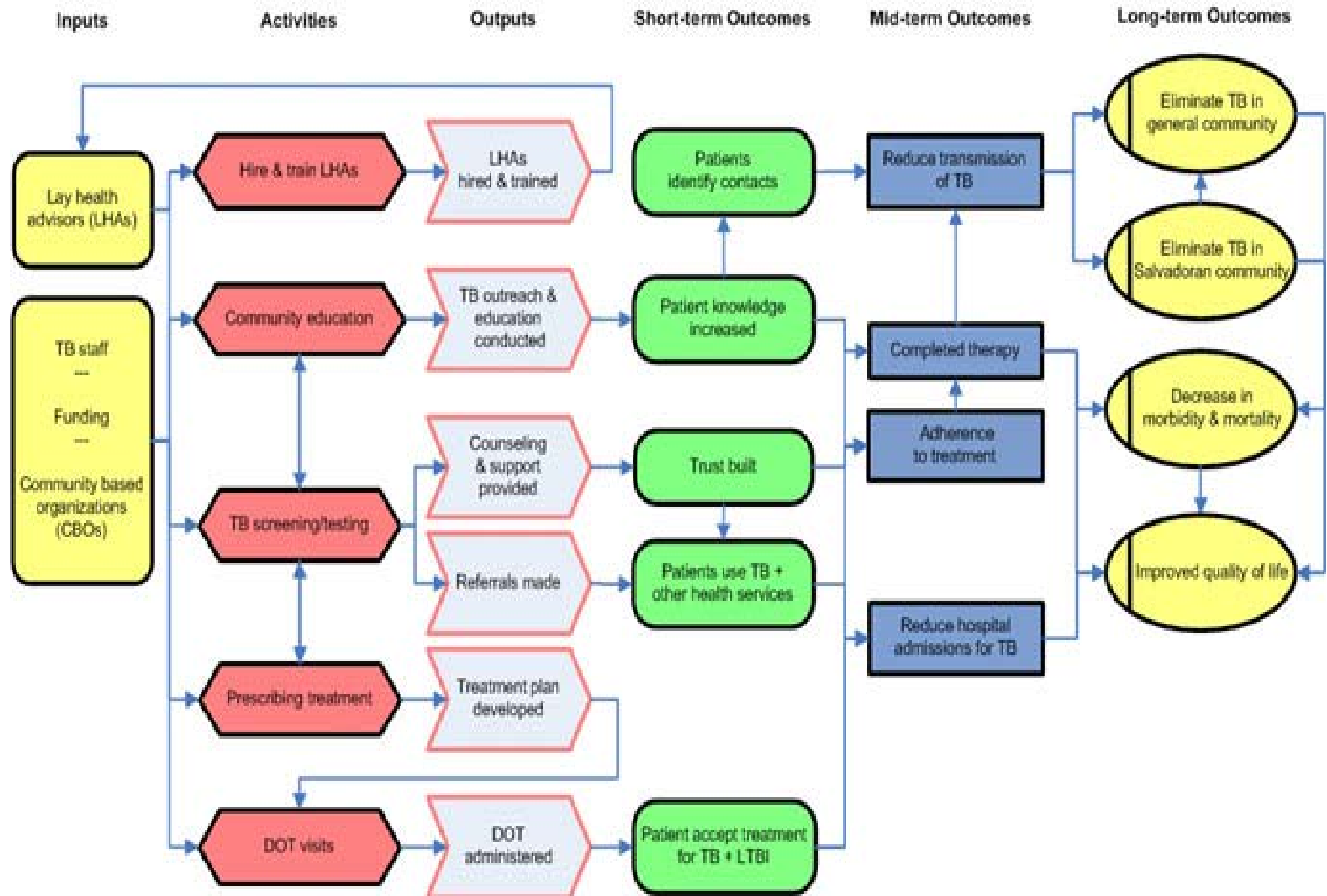
# About Logic Models: Uses

- Improves quality of implementation and impact of programs...
  - Develops consensus understandings of how the program works
  - Clarifies outcomes
  - Guides definition of measures of implementation and impact
  - Illustrates hypotheses to be tested for evaluation research
  - Informs evaluation study design, instrumentation, and analysis
  - Empowers communication about program design and evaluation
  - Supports dissemination
  - Promotes efforts for sustainability

# STEM Workforce Development Logic Model

From the NST ITEST Introduction (p. 3)

| Critical thinking, reasoning, or communication skills |
|---|

| Disciplinary-based knowledge |
|---|

| Motivation to pursue education for STEM-related occupations |
|---|

| Provide students with technology-rich experiences |
|---|

| Awareness of STEM-related occupations |
|---|

| Disciplinary-based practices |
|---|

| Entry into STEM workforce sectors |
|---|

| Dispositions | + | Knowledge | + | Skills | = | Actions | | Dispositions | + | Knowledge | + | Skills | = | Actions |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| STEM Workforce Development Programs | | LEARNING | Students Underrepresented in STEM Careers - K-12 | CAREERS |
|---|---|---|---|---|

| Context / Inputs | | LEARNING | Educators - Formal and Informal | TEACHING |
|---|---|---|---|---|

| Shifting demographics |
|---|

| Instructional and curricular models |
|---|

| Strategies for preparing teachers |
|---|

| Engagement |
|---|

| Knowledge and skills to support STEM workforce teaching and learning |
|---|

| Coherent Sets of Experiences - STEM Content Activities - STEM Career Activities |
|---|

| Motivation |
|---|

| Understanding of STEM-related occupations |
|---|

| Persistence |
|---|

| Entry into careers in the STEM-related workforce |
|---|

| Contribution of business and industry workforce members |
|---|

| Interest in STEM careers |
|---|

| Awareness of careers in the STEM-related workforce |
|---|

| Productive participation in the STEM-related workforce |
|---|

| Utilization and integration of technologies in teaching |
|---|

| Engagement in STEM programs and careers |
|---|

| Competency in STEM-related areas |
|---|

| Student and teacher adoption of technologies |
|---|

| Appreciation for the STEM basis of technological developments |
|---|

| Understanding of the STEM basis of technological developments |
|---|

| Effective and productive ways to ensure broadening participation |
|---|

| Strategies adopted by parents, mentors, and caregivers |
|---|

Color Key

STEM Content Activities & Outcomes
STEM Career Activities & Outcomes
Teacher Professional Development
Partnerships
Cultural Context

*Aligned with the ITEST STEM Workforce Development Helix*

**STEM Workforce Development Logic Model**
From NSF ITEST Program Elements of Broad Areas of Research Guiding Questions
(National Science Foundation, 2015, p. 5)
v.20160307

# STEM Workforce Development Logic Model

- Elements of this model come from the ITEST solicitation

- Goal is to frame a "research agenda" around the program

- Targeted **Disposition**, **Knowledge**, and **Skill** outcomes
are precursors to desired **Action** outcomes

- Outcome model applies to both educators and students, aligned with the STEM outcomes matrix

Provide students with technology-rich experiences

| Dispositions | + | Knowledge | + | Skills | ≠ | Actions | Dis |
|---|---|---|---|---|---|---|---|

LEARNING

Educators - Formal and Informal    TEACHING

| Engagement | Knowledge and skills to support STEM workforce teaching and learning | Coherent Sets of Experiences<br>- STEM Content Activities<br>- STEM Career |
|---|---|---|
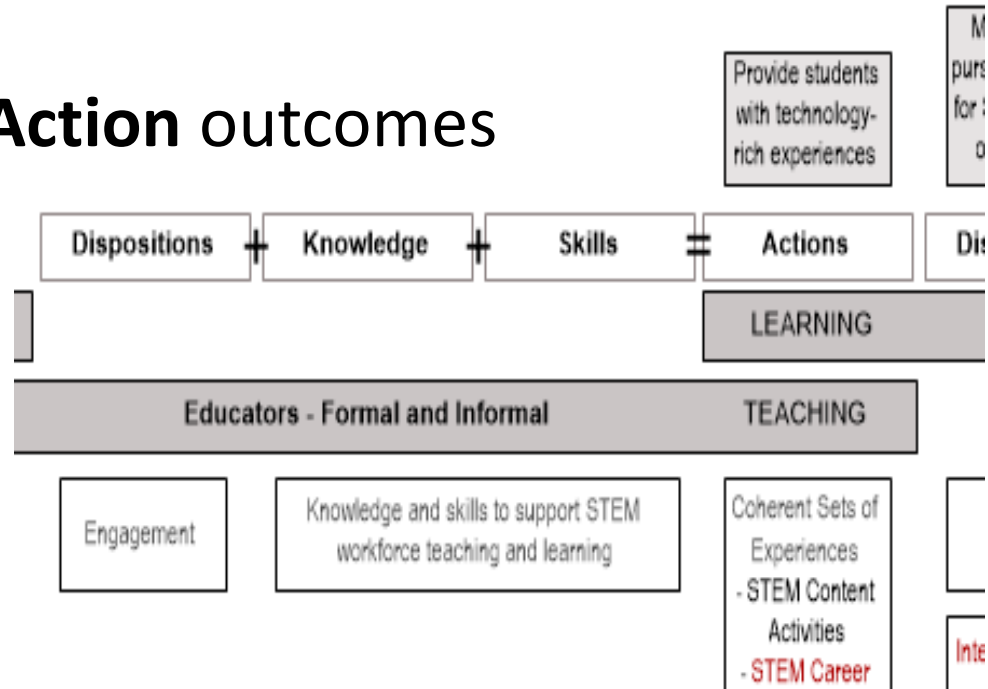
# Program Features

- Context and Inputs
- Strategies to be applied by the program
  - Features
  - Conceptual models (e.g., for problem-based learning)

From the NST ITEST Introduction (p. 3)

Dis

STEM Workforce Development Programs

Context / Inputs

LEARNING

Shifting demographics

Instructional and curricular models

Strategies for preparing teachers

En

Contribution of business and industry workforce members
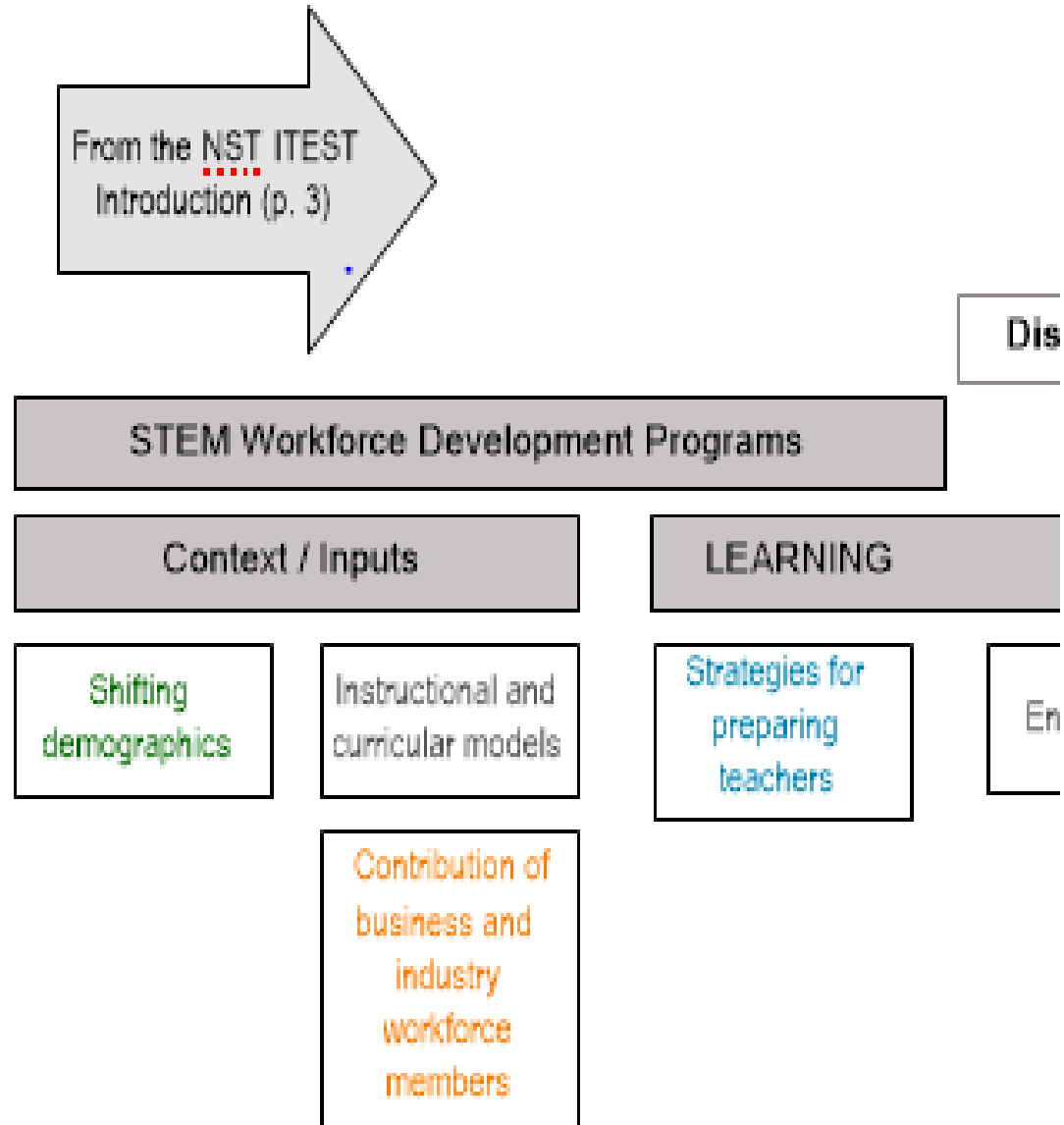
# Teacher Outcomes

- Dispositions
  - Engagement

- Knowledge and Skills
  - To support STEM workforce teaching and learning

- Actions
  - Teaching and learning activities implemented with students

| Dispositions | + | Knowledge | + | Skills | = | Actions | |
|---|---|---|---|---|---|---|---|

| | | | | | LEARNING |
|---|---|---|---|---|---|

| Educators - Formal and Informal | TEACHING |
|---|---|

| Engagement | Knowledge and skills to support STEM workforce teaching and learning | Coherent Sets of Experiences<br>- STEM Content Activities<br>- STEM Career Activities |
|---|---|---|

Utilization and integration of technologies in teaching

Student and teacher adoption of technologies

Effective and productive ways to ensure broadening participation

Strategies adopted by parents, mentors, and caregivers

velopment Logic Model
Broad Areas of Research Guiding Questions
Foundation, 2015, p. 5)
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# Student Outcomes

- Dispositions

- Knowledge

- Skills – note that none are necessarily stipulated for ITEST

- Actions – persistence

- Career outcomes are distal to ITEST projects

| Dispositions | + | Knowledge | + | Skills | = | Actions |
|---|---|---|---|---|---|---|

| Students Underrepresented in STEM Careers - K-12 | CAREERS |
|---|---|

Motivation

Understanding of STEM-related occupations

Persistence

Entry into careers in the STEM-related workforce

Interest in STEM careers

Awareness of careers in the STEM-related workforce

Productive participation in the STEM-related workforce

Engagement in STEM programs and careers

Competency in STEM-related areas

Appreciation for the STEM basis of technological developments

Understanding of the STEM basis of technological developments

Color Key

STEM Content Activities & Outcomes
STEM Career Activities & Outcomes
Teacher Professional Development
Partnerships
Cultural Context

Aligned with the ITEST STEM Workforce Development Helix

# STEM Workforce Development Logic Model

- The model is new and not yet well examined

- Elements are implicitly rather than directly linked; little evidence has been established

- Studies of if-then connections (hypotheses) can be situated in the model

- This would be the basis for a STEM workforce development research agenda

*Does this model have utility?*

# STEM Workforce Development Logic Model

**Guiding Question 3** → Roles played by business and industry workforce members

→ STEM CAM Model Implementation

- Motivation → Become aware of careers in the STEM-related workforce
- Become interested in those careers → Prepared for those careers → *Enter careers in the STEM-related workforce*

## Implementation
*Research and Development Activities and Results*

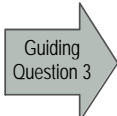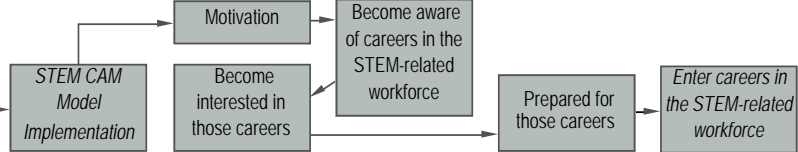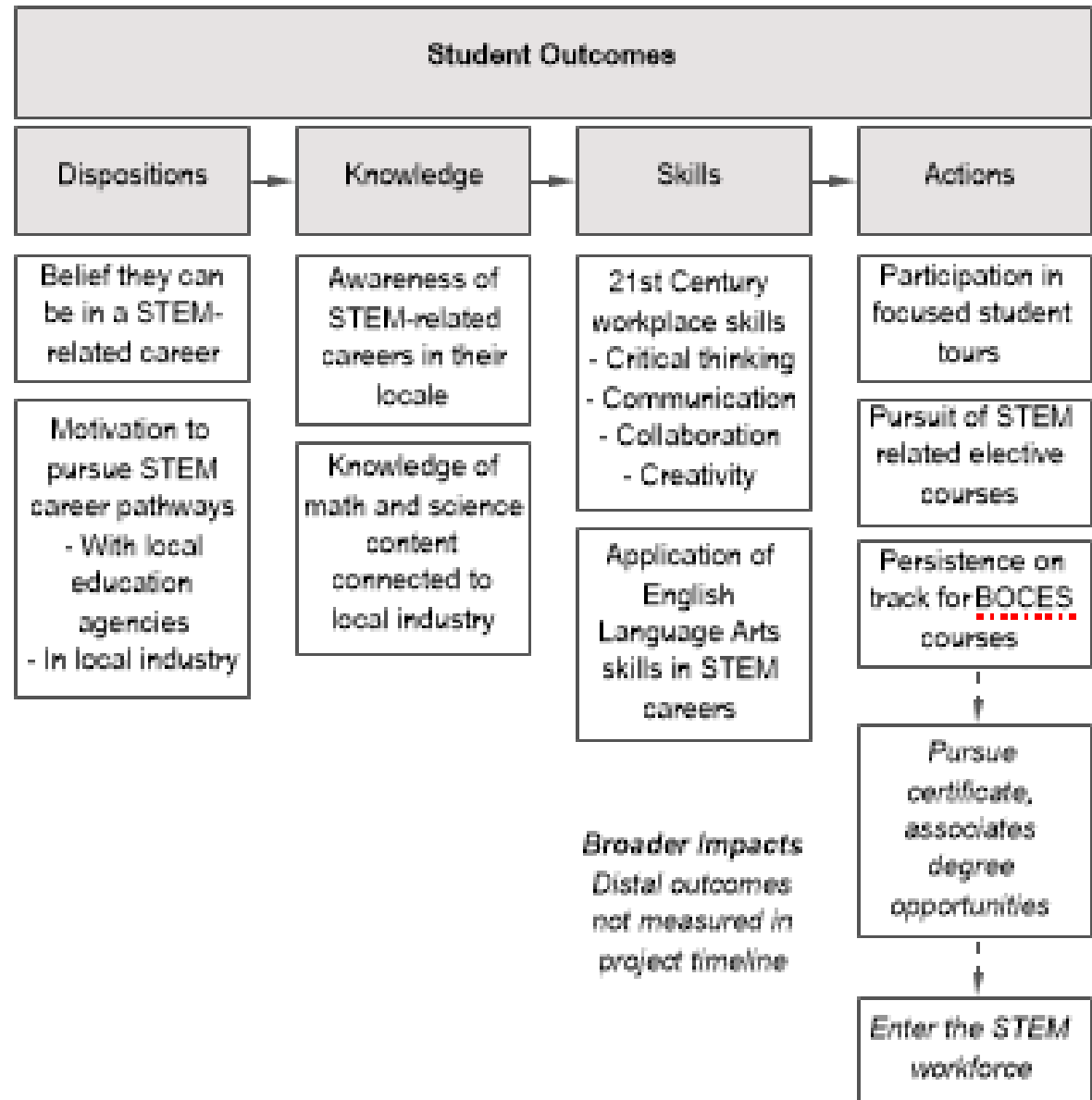| Inputs | Activities | The STEM CAM Innovation |
|---|---|---|
| Partner's Previous Grant Results<br>- MSP<br>- Teaching in Core<br>- 21st CCLC | **Design**<br><br>Finalize industry partnerships, formalize relationships | **Video Content**<br>- Online segments<br>- Overview of company<br>- Virtual tour |
| Industry Partners<br>- FAME<br>- Advanced Manufacturing<br>- Photonics | Record, produce, edit video content<br><br>Establish video hosting | **Companion Kits**<br>- Aligned with CCSS<br>- Tied to industry<br>- Problem to be solved<br>- Connections to resources |
| Education Partners<br>- WFL BOCES<br>- Local colleges<br>- WFL Component Districts | Develop and assemble companion kits<br><br>Align video, PBL, and companion kits to Gr4-7 CCSS | **Teacher PD Package**<br>- Video<br>- Companion Kits<br>- Curriculum Time<br>- Workplace tours<br>- Resources to support PD |
| Classroom Teachers | **Design and Development Research** | |

## Teacher Outcomes

| Dispositions | Knowledge | Skills | Actions TEACHING |
|---|---|---|---|
| Value to students of pathways to STEM-related technical careers | Awareness of STEM career opportunities available to students | Ability to integrate the model into other instruction | Effectively integrate technology-rich PBL STEM career content in teaching |
| STEM teaching self-efficacy | Understanding of career education pathways for students in targeted industries | Ability to integrate 21st Century skills in insturction | Integrate video into instruction |
| | Understanding of applications of math and science content | | Implement companion kits<br>- 21st Century Skills<br>- Problem based learning |
| | Understanding of 21st Century Skills | | Implement classroom Visits by STEM professionals |
| | | | Optional focused student tours of industry partners |

## Student Outcomes

| Dispositions | Knowledge | Skills | Actions |
|---|---|---|---|
| Belief they can be in a STEM-related career | Awareness of STEM-related careers in their locale | 21st Century workplace skills<br>- Critical thinking<br>- Communication<br>- Collaboration<br>- Creativity | Participation in focused student tours |
| Motivation to pursue STEM career pathways<br>- With local education agencies<br>- In local industry | Knowledge of math and science content connected to local industry | Application of English Language Arts skills in STEM careers | Pursuit of STEM related elective courses |
| | | | Persistence on track for BOCES courses |

**Broader Impacts** *Distal outcomes not measured in project timeline*

*Pursue certificate, associates degree opportunities*

*Enter the STEM workforce*

STEM CAM Logic Model
Hezel Associates - Syracuse, NY
v.20160805

# Student Outcomes

- Dispositions
- Knowledge
- Skills
- Actions – including distal outcomes, framing Broader Impacts

| Student Outcomes | | | |
|---|---|---|---|
| **Dispositions** | **Knowledge** | **Skills** | **Actions** |
| Belief they can be in a STEM-related career | Awareness of STEM-related careers in their locale | 21st Century workplace skills<br>- Critical thinking<br>- Communication<br>- Collaboration<br>- Creativity | Participation in focused student tours |
| Motivation to pursue STEM career pathways<br>- With local education agencies<br>- In local industry | Knowledge of math and science content connected to local industry | Application of English Language Arts skills in STEM careers | Pursuit of STEM related elective courses |
| | | | Persistence on track for BOCES courses |
| | *Broader Impacts*<br>*Distal outcomes not measured in project timeline* | | *Pursue certificate, associates degree opportunities* |
| | | | *Enter the STEM workforce* |

Workforce Education Models for K-12 STEM Education Programs:
Exploratory Study on Workforce Impact

David Reider
Education Design, INC

www.educationdesign.biz

# Exploratory Study

Developing an analysis

# Summary

ITEST projects commonly measure content, participation, teacher and student response, and dispositions toward STEM learning.

Workforce Development projects need to examine impact on workforce development issues.

Rethinking and reframing what we measure will have a direct impact on project design.

# Context

STEM Workforce constitutes one of the four strategic categories from the framework for the NSF directorate Education and Human Resources (EHR), in which the ITEST program is located.

# What data do we have:
# Querying the ITEST Population

- ITEST projects (PIs & Evaluators) w/workforce components

- Personal connections and STELAR project database

- limited to projects that engaged HS students w/STEM professionals

- … of 250 total ITEST inventoried projects/32 matches returned/6 responded

- Total of n=12 (+ 6 eDez projects)

# Cursory findings

- Most claimed to engage in some kind of workforce education

- Most did not connect PD or classroom activities with actual workforce experiences

# Strong passive results

- e.g. 92% some kind of workforce element
- 63% providing info on STEM careers
- 45% provide actual workplace experiences

| | none | some extent | fair extent | large extent | Total |
|---|---|---|---|---|---|
| Engage students in understanding the STEM workforce | 0.00% <br> 0 | 27.27% <br> 3 | 36.36% <br> 4 | 36.36% <br> 4 | 11 |
| Provide information about STEM careers | 0.00% <br> 0 | 27.27% <br> 3 | 9.09% <br> 1 | 63.64% <br> 7 | 11 |
| Provide actual workplace experiences (i.e. shadowing, internships) | 45.45% <br> 5 | 0.00% <br> 0 | 9.09% <br> 1 | 45.45% <br> 5 | 11 |
| Provide meetings or presentations by STEM professionals | 9.09% <br> 1 | 18.18% <br> 2 | 9.09% <br> 1 | 63.64% <br> 7 | 11 |
| Connect the ITEST project work to STEM careers | 0.00% <br> 0 | 18.18% <br> 2 | 27.27% <br> 3 | 54.55% <br> 6 | 11 |
| Provide visits to STEM workplace sites | 36.36% <br> 4 | 9.09% <br> 1 | 9.09% <br> 1 | 45.45% <br> 5 | 11 |

# Less strong active engagement

- 75% overall visits to workplace
- … but 36% for inclusion of workforce partners as central to team
- Site visits are typically show-and-tell
- Internships not clearly defined*

| Answer Choices | Responses | |
|---|---|---|
| guest speakers at events or workshops | 63.64% | 7 |
| contributed to project design | 45.45% | 5 |
| field trips to workplace or site | 72.73% | 8 |
| webinar or other online event | 18.18% | 2 |
| guest instructor | 9.09% | 1 |
| part of core project team | 36.36% | 4 |
| no interaction with STEM professionals | 9.09% | 1 |
| internship activities | 36.36% | 4 |

# Internships

- Real-world application of skills
- Modeling workforce
- Non-cognitive skills
- Reciprocated value
- Defining what it is/what it isn't (e.g. working on a project, but not onsite, getting paid vs. not, etc.)
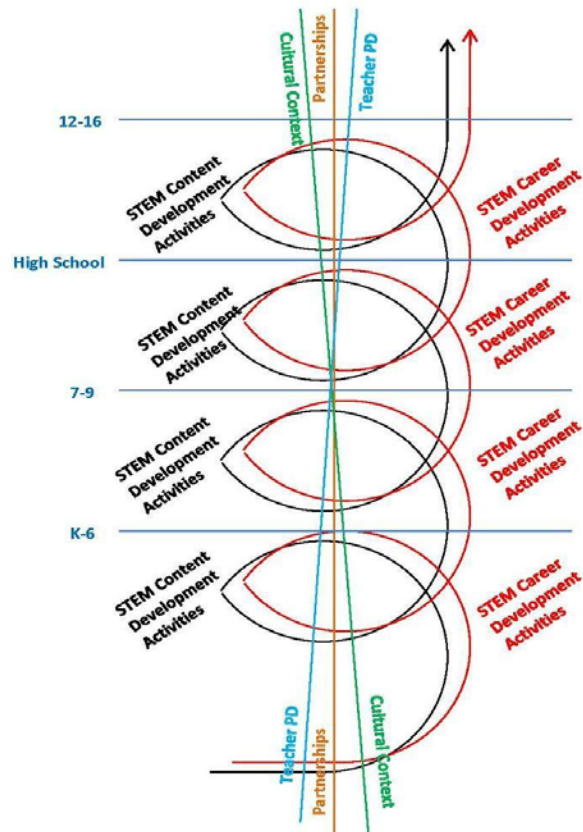
# ITEST STEM Workforce Education Helix

**ITEST Projects should ideally include both:**

A. **STEM Content Activities**
B. **STEM Career Development Activities**

**Three Learning and Support Dimensions:**

1. **Professional Development**
2. **Partnerships**
3. **Cultural Context (schools and workplace)**

# ITEST STEM Workforce Education Helix

# Dimensions of Content & Career

| Dimension | Current, from Existing Projects | Optimal |
|---|---|---|
| Professional Development, Content (PD CON) | STEM subject-matter content delivered to teachers through professional development events, online modules, workshops, or other interactions (e.g., innovative ways to teach 9th grade biology topics) | Same |
| Professional Development, Career (PD CAR) | Training teachers in how to engage their students in career and workforce education activities related to STEM content | Same |
| Partnerships, Content (Part CON) | Training teachers on operational aspects of developing, maintaining, and growing partnerships that connect STEM learning with workforce opportunities | Partnership activities with students that inform the STEM content being delivered in the program |
| Partnerships, Career (Part CAR) | Extent to which partnerships facilitate career information, access, and experiences in the workforce (teacher, school, or ITEST team driven) | Extent to which partnerships facilitate career information, access, and experiences in the workforce (partner driven) |
| Cultural Context, Content (Cultural CON) | Extent to which STEM content delivered to teachers (PD) and students reflects norms and practices related to specific cultural contexts (e.g., language, workforce experience, labor practices, higher education experience) | Same |
| Cultural Context, Career (Cultural CAR) | Extent to which career-based and workforce education activities (e.g., internships, site visits, etc.) reflect norms and practices related to specific cultural contexts (e.g., language, workforce experience, labor practices, higher education experience) | Same |

# Dimensions of Content & Career

Content dimensions typically rate higher



Means of HELIX dimensions n=11
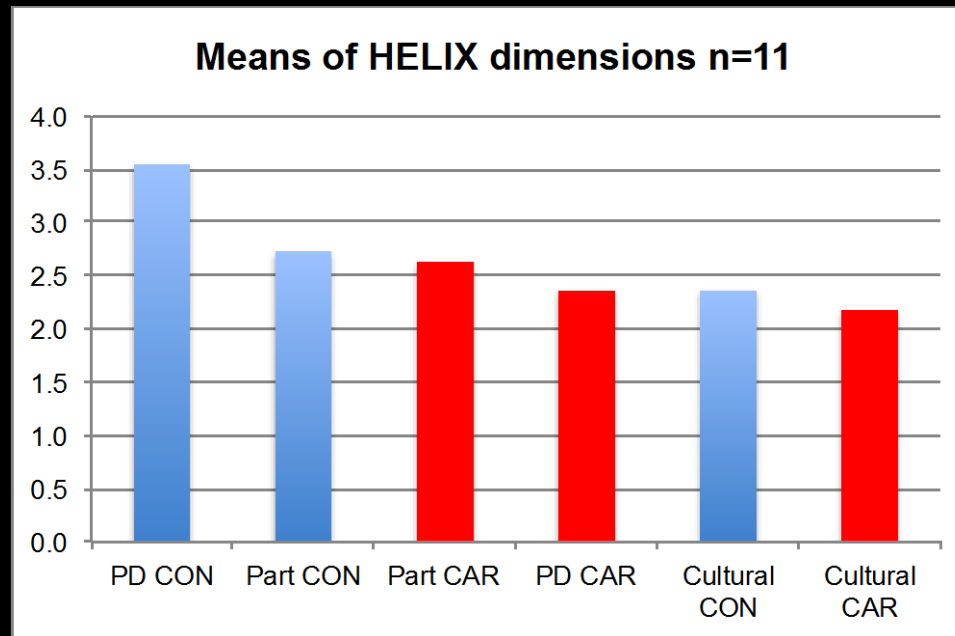
# Internships—What we learned: GRACE Project

- GIS/T Resources and Applications for Career Education (EMU/MiVU/State of Michigan)
- 300 paid student internships/4 years
- GIS skills in industry and municipalities
- Elements of Career very high
- Elements of Content changed from predictions

# Takeaway

- Content, dispositions, change of practice not the only dimensions we need to examine. These inform the efficacy of project on school-based experiences, not application or beyond-project workforce impact.

- Workforce Development projects need to examine impact on workforce development issues.

- Rethinking and reframing what we measure will have a direct impact on project design.

- Need to develop robust tools to measure workforce application issues

# Conclusions/Implications:

- More data needs to be collected on STEM career content and skills particularly as it measures lasting knowledge and skill outcomes for students

- Investigate/develop specific instruments, research methods and recommendations that focus on STEM career and workforce education components.

- More balanced representation of ITEST's influence on students' STEM motivation and participation – to inform design and development of pathways to STEM careers.

# For more information contact:

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David Reider
Education Design
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Or contact the STELAR Team - stelar@edc.org

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# Questions?

# Evaluation link

Please click here to provide feedback on this webinar:
https://edc.co1.qualtrics.com/jfe/form/SV_9vr0MKZ4JDgA4pn