

MNT^eSIG
Micro Nano Technology Education Special Interest Group
Meeting at HI-TEC, July 2019

MNT^eSIG

MICRO NANO TECHNOLOGY
education
SPECIAL INTEREST GROUP

Mission: Foster collaboration between educators at all levels, industry, and agencies for relentless improvement of the micro and nano technology workforce.

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Overview

The MNT^oSIG Conference (formerly MNT Conference) has been held annually since 2011 (in partnership with SCME, NACK, NanoLink, NEATEC, SHINE, and MATEC). The purpose of the MNT^oSIG is to create an opportunity to build and foster the micro- and-nano-technology communities across the country by providing a venue to share ideas and to learn from others who work to train technicians and to stay on the forefront of the industry and workforce needs. Beginning in 2017, the name was changed to MNT^oSIG (Micro Nano Technology Education Special Interest Group) and it began to meet annually in conjunction with the High Impact Technology Exchange (HI-TEC) Conference, as a pre-conference meeting.

In 2019, 47 individuals attended the MNT^oSIG face-to-face meeting at the HI-TEC Conference. This is nearly the same as last year which had 48 attendees. The report that follows summarizes the data collected in the post-meeting survey for the 2019 MNT^oSIG, combined with documentation provided by SCME (Support Center for Microsystems Education). Thirty-seven attendees completed the post-event survey, creating an excellent response rate of 80.8%, compared with a 33.3% response rate in 2018. This means that the data collected this year is more representative of the MNT^oSIG attendees and community.

Institutions

58.8% Community college

29.4% University

11.8% High School

Five participants (13%) were from industry.

Role

79.5% Teacher / Instructor

10.2% Administrator

5.1% Student

5.1% ATE Center Staff

Geographical Region

7.9% Pacific Northwest

18.4% Pacific Southwest

39.5% Northeast

5.3% Southeast

21.1% Northern Midwest

7.9% Southern Midwest

Respondents who were instructors or counselors worked with an average of 127 students each (n=27).

Gender

73% Male

27% Female

Hispanic: 8% were Hispanic

Race

5.6% American Indian or Alaska Native

22.2% Asian

8.3% Black or African American

63.9% White

Quality and Value of The MNT^eSIG Meeting at HI-TEC

Overall quality: 97.3% rated the overall quality as *Excellent* or *Good* (65.4% Excellent, up from 62.5% last year).

The opening keynote received the highest rating overall with a weighted average of 3.70 out of a possible 4.00, giving it a rating of *Excellent*. The small group session (3.68) and closing keynote (3.65) were also highly rated at *Excellent*. The average rating across all aspects of the MNT^eSIG meeting was 3.56. The full distribution of ratings is shown in **Figure 1** below:

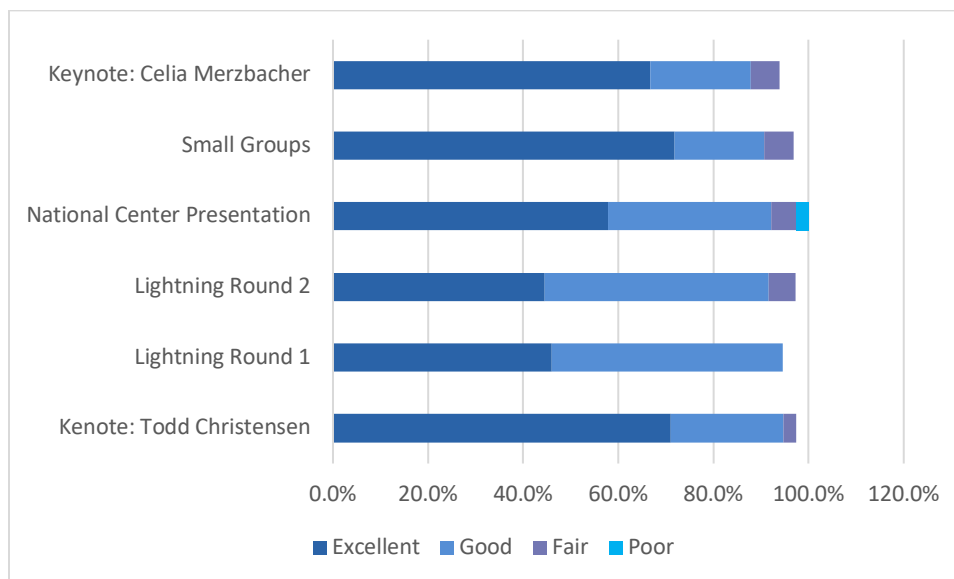


Figure 1 Please Indicate the quality of the following aspects of the MNT^eSIG Meeting n=37

As an indicator of value, participants used a Likert scale to rate the likelihood of recommending the MNT^eSIG as follows: *Extremely Likely*, *Very Likely*, *Somewhat Likely*, *Somewhat Unlikely* and *Very Unlikely*. 92% of respondents were at least somewhat likely to recommend the MNT^eSIG annual meeting at HI-TEC (87% were extremely or very likely) and 95% were at least somewhat likely to recommend joining the MNT^eSIG virtual community (76% extremely or very likely).

Additionally, 94.7% of respondents were extremely or very satisfied with the meeting based on a rating scale of *Extremely Satisfied*, *Very Satisfied*, *Somewhat Satisfied*, *Somewhat Dissatisfied*, *Very Dissatisfied*.

Participants were asked to share specific benefits of participation with the MNT conferences and MNT^eSIG over the years.

Standard qualitative analysis methods were used to examine and analyze the data collected from the open-ended questions. The goal was to identify themes in the responses. The strategy used to identify themes used multiple techniques in a sequential manner:

1. Responses were reviewed to identify key words and concepts.
2. Key words were grouped.
3. Comparisons were made across respondents.
4. Word repetitions/key words and concepts were analyzed.

Table 1 - Benefits from participating with MNT/MNT^oSIG over the years organized in themes.

<p>ATE FUNDING</p> <p>Collaborated w/ other faculty and project PIs/co-PIs on grant proposals and used their products in our program Applying for NSF ATE grant in Oct. 2019</p>
<p>MNT^oSIG COMMUNITY/NETWORKING</p> <p>Opportunity to network w/ attendees Networking between education & industry Remain updated and up-skilled at frontier of Hi Tec Tremendous learning opportunities Students / faculty exchanges Share one's experience and needs for support Expanded contacts; talked with colleague about future grant partnership Participated in MNT conference before MNT^oSIG Participation in MNT^oSIG has directly led to networking and connecting over last 7 years.</p>
<p>PROGRAM IMPROVEMENT</p> <p>Learning about new MNT curriculum materials and using some of it in our program Identify areas of need for our nation</p> <p>Education Resources</p> <p>Learning about a number of resources such as RAIN Yes. RAIN network Working w/ partners from MNT who set up training which helps me in the nano fab lab</p>
<p>IMPROVEMENT IN CURRICULUM/CLASSROOM PRACTICE</p> <p>Program development in nano technology and microscopy; coordinated education programs with Jared & JPL It helps update the technical currency of my knowledge-base and curricula offered at my school. Discovered RAIN network & content expert; joined RAIN network, expanded contacts & curriculum resources; I've introduced SCME modules to multiple faculty members in my department. I've used them myself and I'm working with students on the development of a new kit. My entire program can be directly attributed to MNT^oSIG participation. it simply would not have been possible otherwise. This community is very supportive and has a shared commitment to the common good. I've utilized MNT education materials introduced at MNT^oSIG, from SCME, SHINE, NACK in my class. Had 12 students earn internships to MNT sponsored summer programs. I've adapted several teaching kits into a lab course (MEMS lab) which has been well received by the students. Also plan to utilize mentor connect website to help me prepare an ATE proposal Joined RAIN network and ran many remote sessions We started participating in RAIN more.</p>

Outcomes of the MNT^oSIG Meeting at HI-TEC

Respondents were asked to select their top three gains from participating in the MNT^oSIG face-to-face meeting, from an array of options. The top gains resulting from participation in the community meeting identified by respondents were:

- Network with colleagues and cultivate new connections, each selected by 81.6% of respondents
- Identify best practices, selected by 55.3% of respondents

The distribution of outcomes selected by respondents is shown in Figure 2 below.

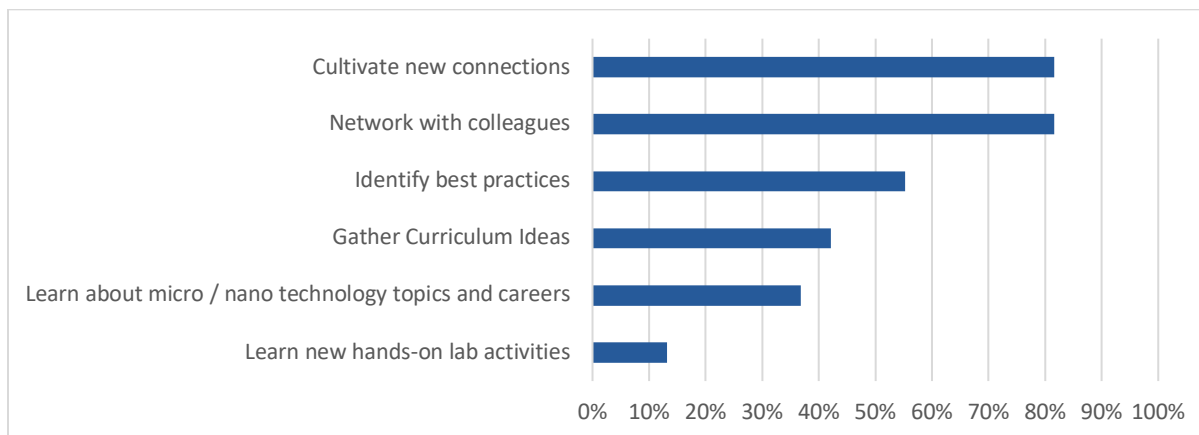


Figure 2 What did you gain from participating in the MNT^oSIG Community Meeting? Please check your top 3. n=38

Likelihood of Implementation in the Classroom

97% of respondents who teach students were *Extremely Likely* or *Likely* to implement ideas and concepts from the MNT^oSIG in their classes (40% were *Extremely Likely*).

Use of Meeting Information & Materials in the Classroom

Respondents selected from options to indicate how they would use the information or materials from the MNT^oSIG meeting, and their responses are in Figure 3 below. The top actions that participants planned to take were relationship-oriented, with following up on connections made at the meeting (selected by 66.5% of respondents) and engaging and growing collaborative partnerships at the top (selected by 58.3%). Facilitating micro-nano technology education at their institutions was also a top choice.

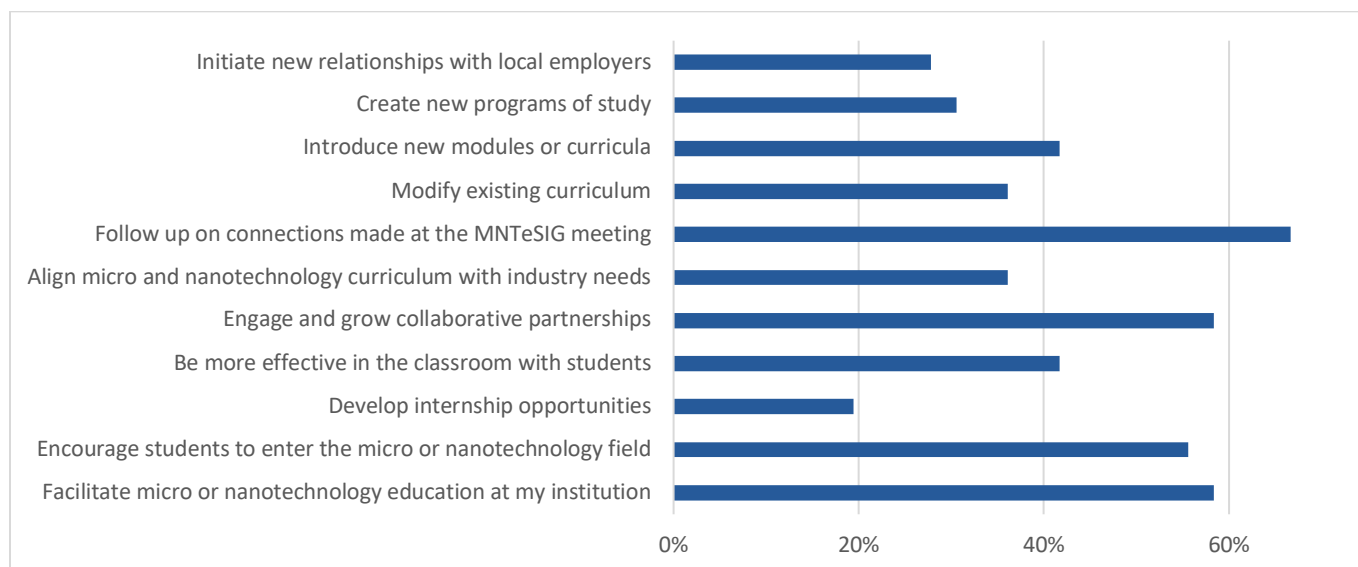


Figure 3 Which of the following actions do you plan to take using the materials or information you gained at the MNT^oSIG Meeting to impact your students or colleagues? (Please select all that apply) n=36

Impact on Students

Nearly 100% of respondents believed that their actions on the classroom with MNT^eSIG materials would have at least some impact on their students; 29.7% believed it would have a high impact.

Respondents selected from a series of potential impacts on students of their use of MNT^eSIG materials in their classrooms. The #1 impact, selected by 65.7% of respondents, was *Increased awareness of micro / nano technologies*. All responses are found in Figure 4 below.

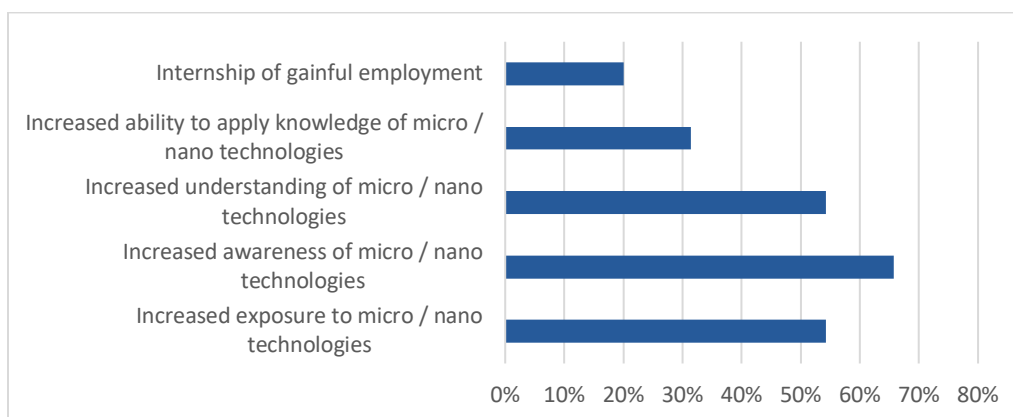


Figure 4 Please indicate how you believe your students will be impacted (please select all that apply) n=35

Future of MNT^eSIG

Respondents were asked to rate the likelihood that they would take an active role in the MNT^eSIG Community in the coming year. All (100%) indicated that they were likely or extremely likely to actively participate (69% *Extremely Likely*).

Survey respondents were also asked four open-ended questions regarding the future for the collaboratory:

- What actions do you intend to undertake in the next six months to carry forward the work of the MNT^eSIG community?
- What challenges do you face in nano-education and what would you like the MNT^eSIG community do to help you?
- What is the most important issue that the MNT^eSIG community should focus on in the next six months?
- What agenda topic(s) would you recommend for next year's MNT^eSIG F2F meeting?

The qualitative analysis produced the following common themes across all of the questions:

- ATE funding
- MNT^eSIG Community/Networking
- Programs/Education System
- Curriculum/Classroom Practice
- Recruiting students and teachers
- Industry/the workplace

Representative statements for each of the themes that emerged for each of the questions, based on the qualitative analysis, are found in **Table 2** below. The complete listing of statements is found in Appendix 1.

Table 2 Representative statements for each of the themes based on qualitative analysis.

What actions do you intend to undertake in the next six months to carry forward the work of the MNT^oSIG community?	What challenges do you face in nano-education and what would you like the MNT^oSIG community do to help you?	What is the most important issue that the MNT^oSIG community should focus on in the next six months?	What agenda topic(s) would you recommend for next year's MNT^oSIG F2F meeting?
<p>ATE FUNDING Applying for NSF-ATE grant for developing educational materials in vacuum technology Prepare an ATE proposal</p>	<p>ATE FUNDING Funding Grants</p>	<p>ATE FUNDING Support ATE Center grant Bridging the experiential MNT Center w/ new Centers and programs being developed</p>	<p>ATE FUNDING Planning for implementation if grant is funded Update on funded projects & centers Update on national center</p>
<p>COMMUNITY/NETWORKING Encourage a new faculty member to join the MNT^oSIG community Attend online meeting. Help w/ curricula committee</p>	<p>COMMUNITY/NETWORKING New comers from industry to field of MNT education need support Not really a challenge. We've developed a number of active/collaborative modules on micro and nano education and we would like to have a place where instructors that have similar materials can share</p>	<p>COMMUNITY/NETWORKING Expanding the MNT^oSIG community Establishing an identity & growing the membership Being flexible in the face of change</p>	<p>COMMUNITY/NETWORKING Organization of MNT^oSIG community Update from working groups & subcommittees on accomplishments of past year industry talks Diversity enhancement</p>
	<p>PROGRAMS/ED. SYSTEM Institutional bureaucracy Sustaining and growing existing programs; scaling up to meet needs</p>	<p>PROGRAMS/ED. SYSTEM MNT Mega center proposal. Recruitment strategies for 2 year college enrollment in micro & nano programs</p>	<p>PROGRAMS/ED. SYSTEM Certifications: Micro, badges, traditional Update from institutions struggling with program death. what strategies seem effective/promising for survival?</p>
<p>CURRICULUM / CLASSROOM PRACTICE Develop more integration of micro nano concepts in current curriculum Connect w/ Marco for his curriculum content Start an intro to quantum class</p>	<p>CURRICULUM / CLASSROOM PRACTICE For those of us with lesser experience creating a speaker's bureau covering different MNT areas would be awesome Standards and agreed upon learning objectives are key to sustainable course/content design</p>	<p>CURRICULUM / CLASSROOM PRACTICE Moving to some agreement on core curriculum and the learning objectives behind the core curriculum</p>	<p>CURRICULUM / CLASSROOM PRACTICE Best practices for curriculum development Applications of nano technology STS Hands on activities</p>
	<p>RECRUITING STUDENTS & TEACHERS Can't offer courses without demand. We have very little nano industry local to my college Student awareness of industry, jobs and available educational programs</p>	<p>RECRUITING STUDENTS AND TEACHERS How to bring information about micro/nano jobs and skills required to potential students and general population. It will help build pipeline for growing industry needs. Train high school teachers & do more professional development.</p>	<p>RECRUITING STUDENTS &TEACHERS New approaches to increasing enrollment Sharing best practices for student recruitment .</p>
<p>INDUSTRY / THE WORKPLACE Connect w/ industry partners</p>	<p>INDUSTRY / THE WORKPLACE NE Indiana does not have a significant MNT to partner with Connecting to industry</p>	<p>INDUSTRY / THE WORKPLACE Create industry partnership Job opportunities & placement for students</p>	<p>INDUSTRY / THE WORKPLACE Bring technicians from the field for panel presentations on their perspectives on skill needs Industry tours</p>
			<p>TOPICS Quantum Possibly IOT Cloud intersection with nano sensors How to reform the educational system in order to apply STEM education earlier in k-12</p>

Summary

Of the 47 attendees, 37 completed the event survey (80.8%), an excellent response rate, and up from 33.3% last year. The surveys provide indicators regarding the quality and outcomes of the Community Meeting that was conducted at HI-TEC in July 2019.

Meeting participants were 60% from community and technical colleges, 40% from the Northeast and approximately 20% from the Southwest Midwest (each), 73% male, 8% Hispanic and 64% White.

The quality overall was rated *Excellent* or *Good* by 97.3% of respondents. Respondents also found the MNT^oSIG sessions to be of high quality. The opening keynote received the highest quality ratings, with the small group round tables and the closing keynote close behind. The average rating of all aspects of the Community Meeting was 3.56 out of a possible 4.00.

92% of respondents were at least somewhat likely to recommend the MNT^oSIG annual meeting at HI-TEC (87% were extremely or very likely) and 95% were at least somewhat likely to recommend joining the MNT^oSIG virtual community (76% extremely or very likely).

Respondents were asked about the benefits they gained from participating with the MNT over the years and four themes emerged:

- ATE funding
- Collaboration and networking
- Program improvement
- Improvement of curriculum/classroom practice

97% were at extremely likely or likely to implement ideas and concepts from the MNT^oSIG in their classrooms, and the top ways they would implement them are following up on connections and engaging new partnerships. Respondents believed that the primary way that this would impact students is increased awareness of micro/nanotechnologies.

Participants were asked four questions about the future of the MNT^oSIG:

- What actions do you intend to undertake in the next six months to carry forward the work of the MNT^oSIG community?
- What challenges do you face in nano-education and what would you like the MNT^oSIG community do to help you?
- What is the most important issue that the MNT^oSIG community should focus on in the next six months?
- What agenda topic(s) would you recommend for next year's MNT^oSIG F2F meeting?

Qualitative analysis showed that responses fell into six categories:

ATE funding
MNT^oSIG Community/Networking
Programs/Education System
Curriculum/Classroom Practice
Recruiting students and teachers
Industry/the workplace

All respondents (100%) indicated that they were likely or extremely likely to actively participate (69% *Extremely Likely*) in the community after the meeting.

APPENDIX 1: Future of MNT^eSIG, Thematic analysis by question

Table 3 Complete set of responses organized by themes.

What actions do you intend to undertake in the next six months to carry forward the work of the MNT ^e SIG community?	What challenges do you face in nano-education and what would you like the MNT ^e SIG community do to help you?	What is the most important issue that the MNT ^e SIG community should focus on in the next six months?	What agenda topic(s) would you recommend for next year's MNT ^e SIG F2F meeting?
<p>ATE FUNDING</p> <p>Work on national center grant Submit NSF ATE MNT center grant Applying for NSF-ATE grant for developing educational materials in vacuum technology Prepare an ATE proposal Write a proposal</p>	<p>ATE FUNDING</p> <p>Funding Grants</p>	<p>ATE FUNDING</p> <p>National center Support ATE Center grant Bridging the experiential MNT Center w/ new Centers and programs being developed Grant proposal Grant opportunities NSF solicitation Writing a grant and plan to train interns</p>	<p>ATE FUNDING</p> <p>Planning for implementation if grant is funded Update on funded projects & centers Update on national center</p>
<p>MNT^eSIG COMMUNITY/NETWORKING</p> <p>Encourage a new faculty member to join the MNT^eSIG community Continue communicating with the groups to work on long term solutions Reach out to the contacts I have made Asses community needs that I can assist with Attend online meeting. Keep in touch through the website Work w/ partners like NPDP & RAIN Recruit new membership Follow up with attendees with similar interests</p> <p>SUB-GROUPS</p> <p>Help w/ curricula committee participate in the faculty professional development sub-group Lead the MNT^eSIG subcommittee on growing leadership Participation in sub-committee Email curriculum of development subcommittee</p>	<p>MNT^eSIG COMMUNITY/NETWORKING</p> <p>Other instructors that have been teaching the same curriculum for 20 years Professional development in MNT^eSIG (the community was very instrumental) New comers from industry to field of MNT education need support Professional development Communicate well and early Coordination w/ MNT institutions & faculty. Not really a challenge. We've developed a number of active/collaborative modules on micro and nano education and we would like to have a place where instructors that have similar materials can share</p>	<p>MNT^eSIG COMMUNITY/NETWORKING</p> <p>Expanding the MNT^eSIG community Establishing an identity & growing the membership Getting more people involved Unintended consequences of nano technology (STS) Being effective in keeping up w/ dynamic changes Better communications Being flexible in the face of change Collaboration for the collective benefit Summary and sharing major findings / issues from round-table discussions</p>	<p>MNT^eSIG COMMUNITY/NETWORKING</p> <p>Organization of MNT^eSIG community Update from working groups & subcommittees on accomplishments of past year industry talks More info on what people are doing How to coordinate MNT education & curriculum nationally Diversity enhancement Support Can we set specific themes for the round-table discussions? It will help focus the discussions after the presentations. Sharing experience Professional development for instructors</p>

	<p>PROGRAMS/EDUCATION SYSTEM</p> <p>Institutional bureaucracy Administration resistance Lack of science flexibility in their curriculum I have limited ability to implement new courses and coursework because of state mandated curriculum Sustaining and growing existing programs; scaling up to meet needs</p>	<p>PROGRAMS/EDUCATION SYSTEM</p> <p>Rebuilding enrollments in nano training programs. MNT Mega center proposal. Recruitment strategies for 2 year college enrollment in micro & nano programs</p>	<p>PROGRAMS/EDUCATION SYSTEM</p> <p>Translating nano program content into emerging technology programs. Certifications: Micro, badges, traditional Update from institutions struggling with program death. what strategies seem effective/promising for survival? How to enhance nano technology infrastructure (faculty & labs) given the declining student enrollment</p>
<p>CURRICULUM /CLASSROOM PRACTICE</p> <p>Continue to implement SCME modules and kits into my curriculum Develop more integration of micro nano concepts in current curriculum Connect w/ Marco for his curriculum content I'm going to type up a proposal for my admin to look at to get her on board with my integration in the existing curriculum Start creating a new discipline called (advanced materials: with the state of California so we can offer advanced materials courses, such as photonics, nano, quantum etc. I'm not sure. I'm more interested in curriculum development Encourage more staff to engage in more professional development activities Develop second course in nano More work on curriculum Start an intro to quantum class</p>	<p>CURRICULUM/CLASSROOM PRACTICE</p> <p>Providing MNT instructional materials that are easily integrated into the curricula of the engineering courses I teach Plan to start a class; would like to use existing curriculum from Marco Curreli How to develop more courses beyond the entry course we have so far For those of us with lesser experience creating a speaker's bureau covering different MNT areas would be awesome Adding mathematical and physical rigor to available materials Standards and agreed upon learning objectives are key to sustainable course/content design Work on better organization of all material How it fits into what I teach and the time to do it.</p>		<p>CURRICULUM/CLASSROOM PRACTICE</p> <p>Best practices for curriculum development Applications of nano technology STS Hands on activities Bio-nanotechnology classroom activities Some hands-on activities</p>
	<p>RECRUITING STUDENTS & TEACHERS</p> <p>Can't offer courses without demand. We have very little nano industry local to my college Student awareness of industry, jobs and available educational programs Finding industrial partners and developing student interest Identifying a need for employees in this field Low student enrollment Providing info to students and industry alike students Awareness of "what it is" and "how to use it in our area" is still a challenge; Presentations from speakers like Todd help to answer questions</p>	<p>RECRUITING STUDENTS AND TEACHERS</p> <p>Recruiting How to bring information about micro/nano jobs and skills required to potential students and general population. It will help build pipeline for growing industry needs. Train high school teachers & do more professional development.</p>	<p>RECRUITING STUDENTS & TEACHERS</p> <p>Recruiting new students and teachers New approaches to increasing enrollment Sharing best practices for student recruitment More discussions on outreach Expose to middle school. Continue to reach out to schools.</p>

<p>INDUSTRY/THE WORKPLACE Connect w/ industry partners</p>	<p>INDUSTRY/THE WORKPLACE NE Indiana does not have a significant MNT to partner with Connecting to industry</p>	<p>INDUSTRY/THE WORKPLACE Industry involvement Create industry partnership Reach out to industry to get them more engaged Ask each participant to identify 1-5 micro/nano companies in their area and create a database of companies engaged with our community for guidance and feedback Moving to some agreement on core curriculum and the learning objectives behind the core curriculum Industry partners Industry outreach Encouragement of industry involvement Job opportunities & placement for students</p>	<p>INDUSTRY/THE WORKPLACE Bring technicians from the field for panel presentations on their perspectives on skill needs, both on their part and their co-workers. Can we invite a speaker in the Bio-MEMS / Bio-NEMS field? Best practices in industry for university internships Industry input Industry outreach National assessment of MNT industry, where? (updated map from NSF proposal overview) Industry involvement Industry tours</p>
			<p>TOPICS Quantum Possibly IOT Cloud intersection with nano sensors How to reform the educational system in order to apply STEM education earlier in k-12</p>
<p>MISC/NA Hope to collaborate w/ MNT^oSIG with my IoT^{EP} ATE grant Meet with my administration and try to implement nano science into the elementary schools</p>	<p>MISC/NA Team doing a great job</p>	<p>MISC/NA Developing differentiated instruction in regards to introducing nanotechnology Middle & elementary school outreach Increasing elementary STEM involvement Present at the NYS science teachers conference in Rochester, NY on Oct. 27th</p>	<p>MISC/NA Moving forward I'll email you if it comes to mind . please remind me if I don't. Posters should be related to nano-tech applications</p>