REPORT OF THE 2013 COLORADO STEM TEACHER PREPARATION SYMPOSIUM

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INTRODUCTION

The need for high-quality teachers in the fields of science, technology, engineering, and mathematics (STEM) is well established. In the Rising Above the Gathering Storm reports (NAS/NAE/IOM, 2007; 2010), the authors document the drastic decline in the STEM workforce as a major obstacle to overall economic growth and recommend overcoming the shortage of highly-qualified K-12 teachers in the STEM disciplines. To meet this challenge, President Obama has made one of his goals of preparing 100,000 new STEM teachers over the next decade (The White House, 2011). The demand for high quality STEM teachers is evident in Colorado as well (CEPA, 2009). Because of these challenges and needs, faculty and staff at the University of Northern Colorado, a leader in STEM Teacher Preparation, provided the first Colorado STEM Teacher Preparation Symposium on December 10, 2013.

The purpose of the symposium was to bring together faculty and staff from programs that address the preparation of STEM teachers in Colorado, and focus on the challenges collectively faced by these programs. The ultimate objective was to develop a shared set of recommendations of how we can meet the challenges and better prepare a workforce of STEM teachers for Colorado. The three main goals that were explored were:

1. *Developing a collective vision of STEM education for Colorado K-12 schools and STEM teacher preparation programs.* What exactly is STEM? Is the new STEM teacher something different from the traditional science, mathematics, or technology teachers from the past? How will all the components of STEM be integrated together? How can the Colorado teacher preparation programs help meet the need for STEM teachers?

2. *Developing an understanding of state-wide education initiatives and policies that impact teacher preparation.* What is happening in the state regarding STEM education? What elements of the roadmap are important to incorporate into STEM teacher preparation programs? How can faculty and staff keep informed of the roadmap's development and use? How can the STEM teacher preparation programs incorporate the education initiatives being developed by the Colorado Department of Higher Education and Colorado Department of Education?

3. *Understanding the implications of SB 191 on placement of pre-service teachers in schools for clinical experiences and student teaching.* How can the teacher preparation programs work with the schools districts to provide value-added benefits for schools/teachers when they accept our teacher candidates into their classrooms? How can the teacher preparation programs and the school districts work together to overcome the current and future shortages of highly-qualified science, mathematics, and technology teachers?

Over 75 participants attended this symposium. Participants represented 1) STEM teacher preparation programs at colleges and universities; 2) school districts; 3) BOCES involved with alternative licensure programs for STEM teachers; 4) state agencies involved with teacher preparation and licensure; 5) legislators concerned with education, teacher quality, and economic growth of Colorado; and; 6)non-profit organizations involved with addressing the concerns of STEM workforce demands in Colorado. A list of participating Institutions of Higher Education (IHE), alternative licensure programs, K-12 schools, government agencies, and non-profit programs is found in Appendix A. The sponsors for this event were Gill Foundation's Gay and Lesbian Fund for Colorado, Colorado Department of Education, Colorado Department of Higher Education, the Colorado Legacy Foundation, and University of Northern Colorado.

The purposes of this report are to 1) inform Colorado STEM Teacher Preparation Programs at Institutions of Higher Education, 2) inform Alternative Licensure Programs in Colorado, 3) inform Colorado state agencies and legislature, 4) inform Colorado's collective work on the STEM Education Roadmap, and finally 5) provide recommendations of how we can help meet the challenge of preparing a workforce of STEM teachers for Colorado.

Organization of the Symposium

The full-day symposium (agenda found in Appendix B) started with Dr. Charles Coble, a nationally recognized leader in STEM Teacher Preparation, a founding partner in The Third Mile Group, and Co-Director of the Science and Mathematics Teacher Imperative. He provided the keynote speech

where he offered a vision on STEM Education and STEM Teacher Preparation. He shared his definitions of STEM, described the President's Council of Advisors on Science and Technology (PCAST), and shared examples of national initiatives that prepare STEM teachers. A synopsis of his talk is found in Appendix C, and his PowerPoint is found at the following website, http://mast.unco.edu/TeacherDevelopment/STEMTeacherPrep/. His talk stimulated a follow-up discussion among participants that focused on the first goal: *Developing a collective vision of STEM education for Colorado K-12 schools and STEM teacher preparation programs.* Eight working-group discussions were facilitated by representatives of the various STEM teacher preparation programs from around the state (a list of participants is found at the above website). Results from this set of working-group discussion are found in the *Findings* section below.

In the second phase of the symposium, a set of speakers informed participants of state-wide initiatives that will impact STEM Teacher Preparation. Yee-Ann Cho of the Colorado Legacy Foundation described the Colorado STEM Education Roadmap. Amber Ptak of the Gill Foundation's Gay & Lesbian Fund for Colorado shared how the 100K in 10 Project supports teacher preparation. Violeta Garcia of Colorado Department of Education explained the work of the PK-12 STEM Think Tank. Finally Leslie Colwell of the Keystone Center provided an update of the Licensing Educators for Academic Development (LEAD) Compact. A synopsis of their talks and website information are found in Appendix D, and the PowerPoint is found at the following website, http://mast.unco.edu/TeacherDevelopment/STEMTeacherPrep/. The presentations were followed by another working-group session to facilitate discussions among all of the participants on the symposium's second goal: *Developing an understanding of state-wide education initiatives and policies that impact teacher preparation*. Results from this working-group discussion are found in the *Findings* section below.

During the afternoon of the symposium, a final panel representing policy makers, district administration, teacher preparation faculty, and practicing K-12 teachers addressed the implications of SB191, Colorado's Teacher Effectiveness Act, on STEM teacher education programs. Panelists were Jennifer Arzberger of the Colorado Department of Higher Education, Linda Barker of the Colorado Education Association, Sed Keller of the Colorado Department of Education, Thomas Klausner of Otis High School, Stacie Datteri of Weld County School District 6, and Rob Powers of the University of Northern Colorado. The panel discussion was followed by a final working-group session to facilitate discussions among all of the participants on the symposium's third goal: *Understanding the implications of SB 191 on placement of pre-service teachers in schools for clinical experiences and student teaching.* Results from this working-group discussion are found in the *Findings* section below.

Throughout the day of the symposium, participants had an opportunity to review posters showcasing Colorado's STEM teacher preparation programs. Posters were provided by participants of the symposium who represented colleges and universities in Colorado. The abstracts of the posters can be found at the following website, http://mast.unco.edu/TeacherDevelopment/STEMTeacherPrep/.

FINDINGS

The findings of this symposium are gathered from an analysis of the notes taken by graduate student scribes who attended each working-group session, videos of the sessions, flip chart artifacts, and participant evaluations of the symposium. Common themes from this analysis were identified. Each working-group discussion was facilitated by a symposium participant from the STEM teacher preparation field. The facilitators were provided with a list of questions (provided in Appendix E) that pertained to the topics of the presentations and the panel discussion. The questions were intended to stimulate discussion and some of the working groups freely deviated from the prescribed list of questions.

Working-group Session I

Eight separate groups discussed questions related to each goal. The first working-group session addressed the topic: *Developing a collective vision of STEM education for Colorado K-12 schools and STEM teacher preparation programs*. Ideas regarding what STEM is and how we integrate STEM into teacher preparation programs was discussed in session one.

What is STEM? This seems like a simple question with a straightforward answer until one starts to have conversations with colleagues. In its original use by the National Science Foundation and other federal agencies, STEM was merely an acronym that referred to the collection of all the science, technology, engineering, and mathematics disciplines "under one roof". Often, the STEM fields are considered collectively in relation to the nation's economic competitiveness, forming the technological foundation of an advanced society (Landgon, McKittrick, Beede, Khan, & Doms, 2011). The relatively recent introduction of engineering education into some K–12 classrooms and out-of-school settings and the 2013 publication of the *Next Generation Science Standards*, which explicitly connect science concepts and practices to those of engineering, have elevated the idea of integration as a potential component of STEM education (NAE & NRC, 2014). From the participants of the STEM Teacher Preparation Symposium, the majority of the comments converged on the ideas of integration and STEM as a new way of thinking. Most participants viewed STEM as a way to integrate knowledge across multiple disciplines and a way to solve problems. Problem based learning (PBL) was commonly mentioned by participants as one means of achieving this integration. This is consistent with the findings of the *Committee on the Integrated STEM Education* (NAE & NRC, 2014) in their report to the National Academy of Engineering (NAE) and the National Research Council (NRC) which states, "Engineering design, like problem-based learning, is associated with a larger number of efforts to teach

STEM in an integrated fashion" (p.43). The symposium participants also noted that instruction on PBL needs to be added to the training of both pre-service and practicing teachers.

A second question put forth at the symposium was what is a STEM teacher? With many school districts already posting job announcements for "STEM teachers", it appears that there may be several conceptions of what this type of teacher actually is. To some, the new "STEM teacher" may be a hybrid of all the disciplines with a little of each science, technology, engineering, and mathematic; however, participants recognize that this would be an unreasonable amount of both content and pedagogical expertise for one teacher. To others, the STEM teacher is anchored in one of the specific disciplines yet has additional leadership qualities to facilitate problem-based learning among a team of teachers that work together to promote STEM learning in a cohesive curricular model. The implications for the teacher preparation programs are profound. There was also a consensus that future elementary teachers have anxiety towards mathematics (and to some extent science) that tends to impair their own content knowledge and ability to teach these subjects.

Other more practical concerns were expressed by symposium participants such as training a teacher within a four year university degree program with adequate content and pedagogical content knowledge is challenging for a traditional science or mathematics teaching licensure program. Adding coursework onto one of these traditional licensure programs to create "STEM leaders" would be impossible since a degree is constrained by the number of credit hours allowed from the state legislature. Public members want students to graduate in four years.

The question of breadth verses depth of content knowledge was also considered. Many professional scientific organizations are emphasizing the need to have teachers reach a level of expertise within only one or two subjects, e.g. physics and chemistry, to be truly qualified to teach that subject (NSTA, 2012). In Colorado, the secondary-science endorsement is already a broad-field licensure

where candidates need to be prepared to teach biology, earth science, chemistry, and physics. However, unless the teacher candidate has multiple content majors, are they really prepared to teach some of the topics when they may have only had two courses in the subject themselves? For example, is the biology major that has taken two semesters of first year college physics truly capable of teaching high-school physics and anticipating potential student misconceptions? On the other hand, many of the rural schools in Colorado may only have one science teacher for a high school; and thus that high school teacher is the science department. The problem is aggravated even further at the elementary level where future teachers have to be capable of teaching all the content areas including the reading, writing, mathematics, social studies, and science. At what point does the effort to prepare these teachers in all the areas only dilute their true expertise?

Working-group Session II

The second working-group session was centered on *developing an understanding of state-wide education Initiatives and policies that impact teacher preparation*. State-wide initiatives that were provided included policies and opportunities outlined by the Colorado's STEM Education Roadmap, 100K in 10 Project, LEAD Compact, and the P-12 STEM Think Tank. For some participants, this was the first time they learned of the state initiatives, and some participants would like to learn how to join these initiatives. In order to more adequately address the policies and the issues described, participants want more effective communications between and within institutions, both in K-12 and in higher-education. Participants also mentioned the importance to include parents in the discussion. Related to the idea of the motivation for reform, was the feeling that teachers' voices and concerns were not being heard among the policy makers. If STEM education reform is going to happen, collaboration must come from all levels. Crosstalk must occur between disciplinary and education faculty at the university/college

level. Instructors in elementary and secondary schools must communicate. And, pre-service and practicing teachers must receive adequate training in the methods of STEM instruction.

Although many of the participants echoed the need for more science and mathematics teachers, there appeared to be few suggestions on how to recruit more into the pipeline other than one comment that the State of Colorado might offer scholarships for STEM teachers. Again some groups experienced the confusion of what we mean by recruiting more STEM teacher candidates. For example, one comment was made that some schools can't even find mathematics teachers so how are they going to find STEM teachers. This appears to emphasize that to some of the participants, "STEM teachers" is merely a collective term for all science and mathematics teachers and others (possible the K-12 schools themselves) are seeing STEM teachers as something new and separate from the existing science and mathematics teachers.

Working-group Session III

A much smaller number of individuals participated in this afternoon session. They focused on *understanding the implications of SB 191 on placement of pre-service teachers in schools for clinical experiences and student teaching*. Participants recommended that pre-service teachers receive information about Colorado's SB 191, Teacher Effectiveness Act with examples of the evaluation process. Multiple individuals expressed concern over the willingness of experienced teachers to take on student teachers if they were going to be penalized because their students' performance scores could be potentially lower. Lastly, individuals expressed concern over the ambiguity associated with the rubric for determining teacher effectiveness. The general consensus was that discussion on these topics and those from other working-group sessions should be continued in future symposia.

Evaluation Results

At the end of the last working group session, participants were asked to complete an evaluation survey of the symposium. The survey consisted of short-answer and Likert-scale questions. The purpose of the survey was to determine why individuals chose to come and participate, what they found useful, what they saw as their challenges in their STEM teacher preparation programs, and challenges they would like addressed at future symposiums. Of the 77 faculty and staff that participated in this symposium, 36 completed the evaluation; i.e. forty-seven percent of the participants provided feedback.

Participation. When participants were asked why they came to the symposium, the top three responses were 1) networking opportunities, 2) opportunity to participate in a discussion on the components of STEM teacher preparation, and 3) opportunity to learn about other STEM teacher preparation programs in Colorado. Participants also shared the challenges that attracted them to the symposium, and the three major themes that emerged were participants were seeking information on 1) how to promote professional environments to promote change, 2) how to implement effective learning strategies, and 3) how to support teachers in this process of change.

Satisfaction with the symposium. All but three respondents expressed appreciation for the opportunity to network and learn from others, appreciated the format for presentations, and felt the discussions were important to them. Those who were not satisfied with the symposium indicated that the symposium did not have focus and the guiding questions of the working-group sessions were not helpful. Twenty six (72%) of the respondents indicated the symposium addressed challenges faced in STEM teacher preparation programs.

Future symposiums. There was not agreement among respondents as to what topics should be discussed at future symposiums. Those that responded suggested possibly reviewing models that help pre-service teachers understand how to use problem-based learning strategies, discussing solutions to

the common challenges, allowing teacher preparation programs to share their strategies, increasing the diversity of our teacher corps, understanding the racialized experiences of minorities, and developing processes to keep up-to-date on information about STEM teacher preparation.

CHALLENGES TO STEM TEACHER PREPARATION

Taking all the ideas and insights that emerged from the symposium as a whole, several challenges to the preparation of STEM teachers prevailed. First, communication among all of the stakeholders is critical. Content faculty in colleges and universities need to talk with the education faculty. The teacher preparation programs need to talk with school districts and understand their needs. State agencies need to listen to representatives of industry as well as teachers and students. To facilitate this communication, all parties need to share a common language, especially when we define what we mean by STEM and more importantly, what is a STEM teacher.

Second, school districts and teacher preparation programs need to work together to overcome the current and future shortages of highly-qualified science and mathematics teachers. The Colorado Academic Standards, Common Core Standards, and Next Generation Science Standards (NGSS) all encourage cross-discipline approaches to student learning. The challenge here is how to best prepare our teacher candidates (and practicing teachers) to be capable of this integration.

If STEM education in K-12 is going to include integrated STEM experiences, teachers need help developing STEM teams. Either future STEM teachers must receive advanced coursework in more than one discipline, and/or, teachers must master how to pull together the expertise from fellow team teachers trained in single disciplines, e.g. engineering, physics, and mathematics. When a team approach is not practical (for example, rural schools) we must help teachers not only to understand the inter-connectivity inherent within STEM but also work to encourage them to design lesson plans to

make STEM connections explicit to students without losing site of the learning goals and learning progressions in the individual STEM disciplines (NEA & NRC, 2014).

Third, the recent implementation of the Educator Effectiveness Act, SB 191, along with the evaluation system may present challenges for teacher preparation programs to secure placements for their teacher candidates during practicums and student teaching experiences. Some supervising teachers from the partner school districts are concerned that the inexperience of teacher candidates may result in lower student performance which may affect the supervising teacher's own evaluation. As districts develop their evaluation procedures and better understand the new rubric for teacher effectiveness, will productive avenues for teachers to host teacher candidates emerge? The teacher preparation programs need to face this challenge by working with school districts to provide value-added benefits for both the cooperating teacher and the schools. Could the future teacher in science and mathematics become natural leaders for the analysis and interpretation of student data to provide evidence of effective teaching? Perhaps, we can provide the future teachers with the knowledge and training.

Finally, a huge challenge we all face is addressing the diversity of future teachers as the nature of our schools continue to change. Recruitment and retention of teachers that students can relate to is imperative. We need to attract more teachers from groups that are currently underrepresented in science, technology, engineering, and mathematics. These future teachers also need to be able to address the challenge of students whose native language is not English or those with learning disabilities. Finally, we also need to meet the needs of rural schools by preparing teachers for this unique challenge of teaching STEM disciplines in remote communities.

RECOMMENDATIONS FROM SYMPOSIUM ORGANIZERS

1. Increase communication among all parties responsible for preparation of STEM teachers.
2. Promote common language to describe STEM teachers and STEM Teacher Preparation.
3. Send a strong message of added value to schools and practicing teachers to work with teacher candidates from Teacher Preparation Programs.
4. Explore integrated STEM majors and/or a new possible STEM license or endorsement.
5. Learn from others' successes; develop a growing awareness of the efforts of other teacher preparation programs from across the nation as we continue addressing the challenges.
6. Include teachers, parents, and students in the discussion of STEM education and STEM Teacher Preparation.
7. Explore and implement ways to increase diversity in STEM teacher preparation programs.

CONCLUSION

The major conclusion to emerge from all the discussions before, during, and immediately after this symposium is that ***this was just the start of a continued discourse***. Representatives from all interested parties welcomed the opportunity to keep the communication going and to include representation from a range of districts in the state. The ongoing challenges will require all parties to add their perspectives to the collective solutions. Hopefully, this symposium is the first of many to come.

REFERENCES

Center for Education Policy Analysis, University of Colorado. (2009). Governor's Colorado P-20 Council brief: Teacher quality. Denver. Retrieved from http://www.ucdenver.edu/academics/colleges/SPA/BuechnerInstitute/Centers/CEPA/Publications/Documents/P20Teacher%20Quality%20Brief.pdf.

Langdon, D., McKittrick, G., Beede, D., Khan, B., & Doms, M. (2011, July). STEM: Good jobs now and for the future. Washington, DC: U.S. Department of Commerce, Economics and Statistics Administration. Retrieved from http://www.esa.doc.gov/sites/default/files/news/documents/stemfinalyjuly14.pdf.

National Academy of Engineering, National Research Council. (2014). STEM integration in K-12 education: Status, prospects, and an agenda for research. Washington, DC: The National Academies Press.

National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. (2007). Rising above the gathering storm: Energizing and employing America for a brighter economic future. Washington, DC: The National Academies Press.

National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. (2010). Rising above the gathering storm, revisited: Rapidly approaching category 5. Washington, DC: The National Academies Press.

National Science Teachers Association. (2012). 2012 National Science Teachers Association Standards for Teacher Preparation. Arlington, VA. Retrieved from http://www.nsta.org/preservice/docs/2012NSTAPreserviceScienceStandards.pdf.

The White House, Office of the Press Secretary. (2011, January 25). Remarks by the President in State of Union address. Washington, DC. Retrieved from http://www.whitehouse.gov/the-press-office/2011/01/25/remarks-presidentstate-union-address.

APPENDIX A

LIST OF PARTICIPATING UNIVERSITIES, COLLEGES, K-12 SCHOOLS, GOVERNMENT AGENCIES, NON-PROFIT ORGANIZATIONS

List of Participating Universities, Colleges, K-12 Schools, Government Agencies, Non-profit Organizations

University & Colleges

University of Northern Colorado, Greeley (Host)

Adams State University, Alamosa

Colorado College, Colorado Springs

Colorado Mesa University, Grand Junction

Colorado State University, Fort Collins

Colorado State University, Pueblo

Metropolitan State University of Denver

Regis University, Denver

University of Colorado, Boulder

University of Colorado, Denver

Western State Colorado University, Gunnison

School Districts

Boulder Valley School District

Denver Public School District

Jefferson County School District

Otis School District

Weld County School District 6

Government Agencies

Colorado Department of Education

Colorado Department of Higher Education

Non-profit Organizations

Colorado Education Association

Colorado Legacy Foundation (now Colorado Education Initiatives)

Colorado Geographic Alliance

eNet Colorado

Gill Foundation's Gay and Lesbian Fund for Colorado

HortSTEM

SmartGirl

Keystone Center

APPENDIX B

COLORADO STEM TEACHER PREPARATION SYMPOSIUM AGENDA

Colorado STEM Teacher Preparation Symposium Agenda

University of Northern Colorado
Panorama Room, University Center
Tuesday, December 10, 2013

8:00-8:30	Registration and continental breakfast
8:30-8:40	Welcome to symposium (UNC Provost Robbyn Wacker)
8:40-8:45	Orientation to symposium (Lori Reinsvold)
8:45-9:45	Keynote Address: National Speaker, *Charles Coble* Topic: Vision of STEM Education and STEM Teacher Preparation Founder and current Partner of The Third Mile Group, an independent education and social policy organization, committed to accelerating positive changes in schools and communities.
9:45-10:00	Walking Orders/Break/Transfer to working session
10:00-10:40	Working Group Sessions I
10:40-11:40	General Session Presentation: Representatives from CLF, CDE, and Keystone Topic: Colorado's STEM Education Roadmap and other State Initiatives *Yee-Ann Cho*, Vice-President, Initiatives, Colorado Legacy Foundation *Amber Ptak*, 100Kin10 Funding Partner, Director of Education Programs, Gill Foundation's Gay & Lesbian Fund for Colorado *Violeta Garcia*, STEM Coordinator, Colorado Department of Education *Leslie Colwell*, Keystone Center, The Licensing Educators for Academic Development (LEAD) Compact
11:40-11:55	Walking Orders /Break/Transfer to working session
11:55-12:35	Working Group Sessions II
12:35-1:40	Lunch and Poster Session
1:40-2:40	General Session Panel Discussion: CDHE, CDE, CEA, School District, STEM Education Faculty, Rural HS Teacher Topic: Challenges of STEM Teacher Preparation in Colorado: Implications of SB 191 *Jennifer Arzberger*, Educator Preparation Project Manager, Colorado Department of Higher Education *Linda Barker*, Director of Teaching and Learning, Colorado Education Association *Dr. Stacie Datteri*, Executive Director of Learning Services, Weld County School District 6, Greeley and Evans *Sed Keller*, Senior Consultant, Educator Effectiveness, Colorado Department of Education *Tommy Klausner*, Rural Mathematics Teacher, Noyce Scholar, Otis High School, Otis, CO *Dr. Rob Powers*, Professor of Mathematics Education, STEM Teacher Preparation Faculty, UNC Math
2:40-2:55	Break/Transfer to working group session

2:55-3:40	Working Group Sessions III
3:40-4:00	General Session Presentation: Symposium Summary and Wrap-up (Lori Reinsvold)

APPENDIX C

SYNOPSIS OF DR. CHARLES COBLE'S PRESENTATION AT THE 2013 COLORADO STEM TEACHER PREPARATION SYMPOSIUM

Synopsis of Dr. Charles Coble's Presentation at the 2013 Colorado STEM Teacher Preparation Symposium

- A great need for STEM workers
    - Growth in STEM jobs has been three times greater than that of non-STEM jobs over the last 10 years.
- Vast majority of our society need the knowledge and skills necessary to get a good paying job, and a quality STEM education is a pathway to their success.
    - Need improvements in literacy, numeracy and proficiency in problem-solving.
- PCAST
    - Adoption of empirically validated teaching practices;
    - Advocate and provide support for replacing standard laboratory courses with discovery-based courses;
    - *For domestic competiveness need a workforce with fundamental science, technology, engineering, and math skills and broad problem-solving skills, decision-making skills, and people skills that do not emerge from a conventional K-12 education.*
    - *We need Problems-based Learning instruction.*
- *Turning the Tide,* an early STEM initiative of the National Association of System Heads (NASH) recommended the following strategies for producing the mathematics & science teachers our schools need
    - *Engaging arts and sciences faculty as leaders of innovation and reform (Examples noted at symposium are found at Colorado's universities and colleges)*
    - *Developing new pathways and incentives to enter the teaching profession (Examples at symposium are found through NSF's Robert Noyce Scholarship Programs)*
    - *Establishing ambitious, widely shared and measurable goals with support and accountability for action (examples include University of California and University of North Carolina systems)*
    - Source: Charles R. Coble, Catherine Walker, Katy Anthes, Ned Erickson and Arika Long. National Association of System Heads (NASH), Washington, DC 2006
- Association for Public and Land-grant (APLU) Institutions kicked off the Science and Mathematics Teacher Imperative (SMTI) where Chancellor's and President's pledged to increase the QUANTITY and QUALITY of science and mathematics teacher preparation on their campuses.
    - Members include CU-Boulder, CU-Denver, and CSU
    - SMTI guided by this perspective of science and math teacher education it is an all-campus responsibility that begins before it begins and it is not over on graduation day.(see powerpoint diagram)
        - Developed a well-vetted tool, **Analytic Framework,** which institutions have used to assess the quality of their programs
- What is STEM?
    - SCIENCE, MATH, TECHNOLOGY, ENGINEERING – all present and accounted for.
    - Example of process – Strategies that engages minds® by North Carolina Science, Technology and Mathematics Center.

    - The STEM Pipeline that includes workforce and economic impact, informal education, STEM Literacy in university, strategic Investments & innovation, Public Television, the Research Triangle Park, college and career readiness, teacher quality, leadership and support.
- Attributes of a STEM School
    - Integrated Science, Technology, Engineering and Mathematics curriculum, aligned with state, national and international, and industry standards
        - Problem-based learning
    - On-going community and industry engagement
    - Connections with postsecondary education
- Teacher Prep for STEM/PBL Schools (Pathways Project of NYC & National Academy of Sciences (2010))
    - More content courses require for entry and exit
    - Required capstone course to 'put it together'
    - Practical courses to learn specific practices – teaming, questioning, inquiry
    - More knowledge of local district curriculum
    - Intern experiences that are congruent with subject/grade level and future teaching expectations
    - Examples: UT-Teach, Austin, TX; Indiana STEM Teach; NC STEP (STEM Teacher Education Program); Teach For America; Carnegie Science Center/Chevron STEM Center; Bank Street College – NY Museum of Natural History/Leadership in Museum Education
- Resources
    - Two divisions within NSF's Education and Human Resources (EHR) are particularly relevant to the issue of STEM teacher preparation- *Division of Undergraduate Education (DUE)
        - A key DUE program is the Robert Noyce Teacher Scholarship Program (www.nsfnoyce.org)
        - Division of Research on Learning in Formal and Informal Settings (DRL)
    - The Discovery Research K-12 program (DRK-12) seeks to significantly enhance the learning and teaching of (STEM)
        - The DRK-12 program has four major research and development strands: (1) Assessment; (2) Learning; (3) Teaching; and (4) Implementation Research.

APPENDIX D

SYNOPSIS OF THE PRESENTATION OF YEE-ANN CHO, AMBER PTAK, VIOLETA GARCIA, AND LESLIE COLWELL AT THE 2013 COLORADO TEACHER PREPARATION SYMPOSIUM

Synopsis of the presentation of Yee-Ann Cho, Amber Ptak, Violeta Garcia, and Leslie Colwell at the 2013 Colorado STEM Teacher Preparation Symposium

Yee-Ann Cho, Colorado Legacy Foundation (Now Colorado Education Initiatives)

Colorado STEM Education Roadmap and Action Plan (Three years)
http://www.coloradoedinitiative.org/our-work/stem/

- In partnership with Governor's Office
- Effective STEM education contains deep content and delivery focused on developing critical thinking and 21st century skills.
- Core value
    - Each individual has the potential to succeed
- Mission
    - STEM education should unlock potential of each individual
- Purpose
    - Increase coordination, alignment, communication, and improvement of STEM Education for excellence & equity, relevant experiences, transferable competitive skills.
- A framework to support educator effectiveness, content standards, industry and career academic plans, graduation guidelines
    - Focus on Next Generation Learning

Amber Ptak, Gill Foundation's Gay and Lesbian Fund for Colorado

100K in 10 STEM teachers by 2020 http://www.100kin10.org/

- National and state-wide support to develop and support STEM teachers

Violeta Garcia, Colorado Department of Education

STEM Think Tank http://www.cde.state.co.us/stem

- Coordinate state-wide conversations to support Colorado STEM Education Roadmap
- Focused groups
    - Research
    - Recourses
    - Teacher Professional Development
    - Teacher Preparation
    - Outreach and Planning

Leslie Colwell, Keystone Center

Licensing Educators for Academic Development (LEAD) Compact

https://www.keystone.org/images/keystone-center/spp-documents/Education_Policy/LEAD-Compact-Cover-Memo-Participants_FINAL.pdf

- Inform legislation in the 2014 session regarding the entire educator continuum: preparation, licensure, professional development, and career pathways.

APPENDIX E

WORKING-GROUP SESSION QUESTIONS

Working-Group Session Questions

Theme 1: What is STEM K-12 and how do we integrate science, mathematics, technology and engineering into the teacher preparation programs?

1. What is STEM?

2. What is a STEM teacher? Elementary classroom vs. secondary classroom?

3. Is a STEM teacher different from our current mathematics, science, or technology teachers, or is it merely a collective term that includes all of these types of teachers (just as science teacher includes biology teachers, chemistry teachers, physics teachers, and earth systems teachers)?

4. Would a new teacher license endorsement be required for STEM beyond the science or math endorsement?

5. What coursework or experiences would this STEM teacher need to have in order to be ready to teach in Colorado schools?

6. Are the Scientific and Engineering Practices outlined in the Next Generation Science Standards (NGSS) driving K-12 STEM education?

7. How do we integrate mathematics, science, technology, and engineering in the experiences of teacher candidates during their teacher preparation programs?

8. Since science and math teacher preparation are often separate programs, how do we promote more integration and cross communication?

9. Is it better to have single topic specialists as teachers (e.g. biology teachers, math teachers, robotics teachers) as compared to STEM teachers that may need to be generalists by practicality?

Facilitator's Prompting Questions for Working Group Session II

Theme 2: How can the Colorado STEM Education Roadmap and other state education reforms support teacher preparation programs to prepare educators for the Next Generation classroom?

1. What efforts are you advancing at your institution that will improve STEM education in Colorado?

2. What elements of the Roadmap are important to incorporate into STEM teacher preparation programs?

3. How is your institution/agency addressing the issues of STEM teacher preparation?

4. How can your faculty and staff keep informed of the roadmap's development and use?

5. How can the STEM teacher preparation programs incorporate the education initiatives being developed by the Colorado Department of Higher Education and Colorado Department of Education?

6. How can the CDE Think Tank support you and engage you in improving STEM teaching and learning in Colorado?

7. What is the best way to promote communication between the groups leading the statewide initiatives for entire teacher education programs and specifically the STEM teacher preparation programs?

8. What strategies do you have in place that supports the 100kin10 goals to recruit and retain 100,000 STEM teachers in 10 years?

9. What reactions do you have to the update on the work of the LEAD Compact you would like to share?

Facilitator's Prompting Questions for Working Group Session III

Theme 3: What are the challenges of SB191 to STEM teacher preparation?

1. SB191 will require all school districts to develop new teacher and principal evaluation plans that include student performance in the evaluation in some manner. What are some of the models of these evaluation plans being implemented at school districts?

2. How is STEM integrated throughout the Professional Practice Standards and Colorado Academic Standards?

3. How can STEM educators help their school/district succeed?

4. How can teacher preparation programs prepare STEM teachers to advocate/highlight this interconnectedness in their district?

5. How can we prepare STEM teachers to be able to build meaningful performance tasks to better understand their students' content knowledge and also be used in their body of evidence for educator effectiveness?

6. STEM educators are often called on by district leaders to analyze and interpret data for the district. How can the teacher preparation programs help to support these value-added skills for our STEM teachers?

7. How might the concerns for inclusion of student performance affect the placement of teacher candidates for clinical experiences and student teaching?

8. How can teacher education programs provide value-added benefits to the school districts?

9. Since many of the districts are still in early phases of implementation of their evaluation plans, can teacher preparation programs help shape these teacher/principal evaluation plans?

10. How do we facilitate more discussion among the teacher preparation programs, school districts, state legislators, and policy makers?

11. What is the role of the school districts in meeting the shortage of qualified STEM teachers?

Are there other challenges beyond SB191 that affect the teacher preparation and licensure programs in Colorado (such as the high number of rural school districts)?