



School Science and  
Mathematics Association  
Founded in 1901

Under the Big Sky:  
Where BIG STEM Ideas come  
to Life!!

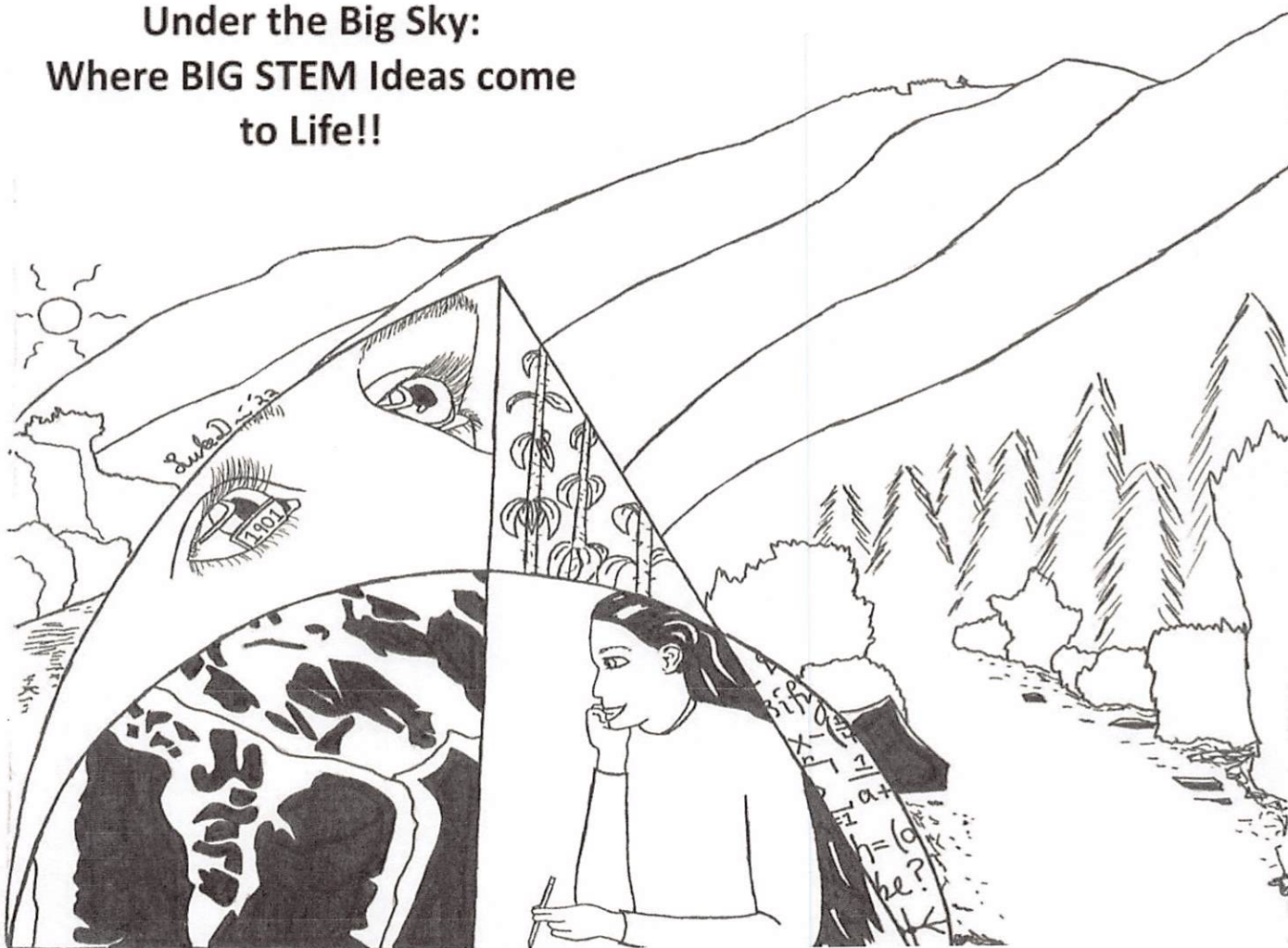


Photo Credit: Luke Davis, mathematics graduate student at the University of Montana, created this art knowing the theme of the convention

**SSMA Annual Convention**  
**Missoula, Montana**  
**October 27– 29, 2022**

## TABLE OF CONTENTS

### VOLUME 9

|                                                                                                                |           |
|----------------------------------------------------------------------------------------------------------------|-----------|
| <b>RECRUITING MATHEMATICS AND SCIENCE TEACHERS: THE UTM NOYCE SCHOLARS PROGRAM.....</b>                        | <b>6</b>  |
| Elliot S. Elliott                                                                                              |           |
| <b>TEACHER CANDIDATES NOTICING SCIENCE.....</b>                                                                | <b>12</b> |
| Christine G. Schnittka, Mark Brennemen, & Danielle Hudson                                                      |           |
| <b>CREATING A SUSTAINABLE SUPPLEMENTAL INDUCTION PROGRAM FOR STEM TEACHERS.....</b>                            | <b>22</b> |
| Colleen McClean Eddy, Karen Bump, & Zhenhua Huang                                                              |           |
| <b>VIDEO-BASED TASK ANALYSIS ON GRAPHS OF THE QUADRATIC FUNCTION.....</b>                                      | <b>30</b> |
| Miran Byun & Eunmi Joung                                                                                       |           |
| <b>EXPLORING STEM EDUCATION IN PREKINDERGARTEN SETTINGS: SYSTEMATICS REVIEW.....</b>                           | <b>38</b> |
| Jeffery Radloff & Kate McCormick                                                                               |           |
| <b>BRING KITES TO YOUR STEM CLASSROOM WITH NASA AREN.....</b>                                                  | <b>47</b> |
| Suzanne Taylor, Jeanette Chipps & Mike Jabot                                                                   |           |
| <b>LEARNING BY SCIENTIFIC DESIGN: USING COGNITIVE SCIENCE TO IMPROVE MATH AND SCIENCE METHODS COURSES.....</b> | <b>55</b> |
| Andrea Foster & Kristin Martin                                                                                 |           |
| <b>ENGAGING WITH COFFEE: A TEACHER'S EXPERIENCE WITH AUTHENTIC INQUIRY AND IDENTITY.....</b>                   | <b>63</b> |
| Jeannette Chips                                                                                                |           |
| <b>GOING PLACES: TRANSITIONING FROM CLASSROOM INSTRUCTION TO INFORMAL SCIENCE.....</b>                         | <b>71</b> |
| Merryn Cole, Jake R. Johnson, & Maizie V. Dyess                                                                |           |
| <b>PARENT MATHEMATICS PROGRAM: PERCEIVING PRESERVICE TEACHERS' PEDAGOGY AND GROWTH MINDSET .....</b>           | <b>80</b> |
| Anh Pham, Bailey Devine, Emily P. Bonner, & Traci Elmore                                                       |           |

## CREATING A SUSTAINABLE SUPPLEMENTAL INDUCTION PROGRAM FOR STEM TEACHERS

**Colleen McLean Eddy**  
colleen.eddy@unt.edu

**Karen Bump**  
karen.bump@unt.edu  
University of North Texas

**Zhenhua Huang**  
zhenhua.huang@unt.edu

### Abstract

*This paper is part of a larger project seeking to create a sustainable infrastructure for engineering students to become STEM teachers in high-need schools. Induction programs are a key component for new teacher retention. A review of literature and systematic review of district partners' induction programs provides content for determining what components are needed for a supplemental induction program. One district focuses more on the expectations of mentors, and the other focuses more on new teacher expectations. The initial findings suggest including financial support for both mentors and mentees, providing university engineering faculty mentors, and opportunities for STEM mentees to collaborate.*

Keywords: induction programs, novice teachers, STEM teachers, teacher retention

### Introduction

This paper is part of a larger project seeking to create a sustainable infrastructure for engineering students to become STEM teachers in high-need schools, resulting in a pipeline for minoritized students from high school to college to become engineers. Developing pathways for engineering candidates from minoritized groups adds to the small number of current engineering teachers in high-need school districts (Bischoff et al., 2014; Hansen & Quintero, 2018).

### Purpose of the Study

The purpose of the study is to determine what components of a supplemental collaborative induction are needed between a university and partner school districts to support and retain engineering majors as STEM teachers.

### Related Literature

Many school districts have added engineering courses and engineering content to science and mathematics courses to their secondary programs as a way to integrate mathematics, science, and technology through problem-solving and collaboration (CADRE, 2013). Thus, recruiting engineering students to become STEM teachers has gained importance. The Texas Education Agency has mandated the addition of 'scientific and engineering practices' to the Texas Essential Knowledge and Skills K-12 by 2023 (TEA, 2021). One of the best ways to fulfill these education

needs is by recruiting engineering majors to become STEM teachers and retaining these teachers through innovative induction programs.

Induction is a key component of teacher retention, and many states including Texas require school districts to have a new teacher induction program (Ingersoll & Smith, 2004; Ingersoll, 2012; McConnell, 2017). One qualitative study in an urban school district regarding the induction of new science and mathematics teachers included science and mathematics faculty from the university as part of the induction team (ndunda et al., 2017). Other induction programs with strong subject-specific mentoring included a mentoring overlap between the student teaching phase and the new teacher induction that included cooperating teachers and STEM faculty (McConnell, 2017; Morrell & Salomone, 2017). Smith and Ingersoll (2004), using the data set from the Schools and Staffing Survey, found that having a mentor in the same field reduced the risk of leaving by 30%.

ndunda and colleagues (2017) described the team as a professional learning community (PLC) where the faculty lead the PLC. The PLC occurred every week for 1-2 hours either after school or on Saturday, during which time they reviewed student data, completed lesson planning, and identified which instructional strategies worked or did not work. This also included observations in the classroom and debriefings. University faculty served as support beyond the weekly meetings that included “(a) shared values and mission, (b) shared and supportive leadership, (c) collective learning and its application, (d) supportive conditions, and (e) shared personal practice” (ndunda et al., 2017, p144). Smith and Ingersoll (2004) reinforced the importance of a common planning time with their mentors as it reduced the risk of leaving by 43%.

For STEM career changers, peer support is essential for retention and job satisfaction (Grier & Johnson, 2009; Koehler et al., 2013). In their qualitative case study of six STEM career changers, Grier and Johnson (2009) indicated that they valued the experiences of their peers as well as being able to socialize with them. Koehler and colleagues (2013) reinforce Grier and Johnson’s (2009) conclusion and include a recommendation for STEM career changers as a cohort in the certification program so that it can continue once they are in the classroom.

The content of induction programs is important as well. Researchers describe how the content of induction programs should include student-centered instructional practices, such as student engagement and evidence of student learning (Thompson et al., 2013; Wong & Luft, 2015). Wong and Luft (2015) found too that teachers who were more student-centered than teacher-centered were more likely to continue teaching.

Communication with campus administrators is another important factor along with a subject-specific mentor and planning time with them (Ingersoll, 2012; Wynn et al, 2007). Campus administrators included the principals, department chairs, and others. The offerings by district and campus administrators matter too, such as seminars for beginning teachers and opportunities to collaborate with other teachers. In Kearney's (2017) international research, the addition of teacher aides and reduced teaching load or schedule were found to contribute to new teacher retention.

A variety of induction programs exist, but those most successful have a subject-specific mentor and a common planning time to collaborate (Smith & Ingersoll, 2004), along with two or more of the following for the greatest impact (Ingersoll, 2012): 1) communication with school administrators (Ingersoll, 2012; Wynn et al, 2007), 2) beginner seminars (Ingersoll, 2012), 3) collaboration with colleagues (Ingersoll, 2012), 4) having a teacher aide (Ingersoll, 2012; Kearney, 2017), and 5) reduced teaching load or schedule (Ingersoll, 2012; Kearney, 2017). In addition, STEM career changers benefit from peer support and socialization from other STEM career changers as they transition from the preparation program to the classroom (Grier & Johnson, 2009; Koehler et al., 2013).

### Methodology

After a review of the literature regarding the needed components of a successful induction program as summarized above, a content analysis of the partner district induction programs was evaluated. We discuss the commonalities and differences between the induction programs and then how they relate to the literature. Following this we discuss the implications of sharing this information with partner districts and what components are being considered for the supplemental induction program. For the purposes of anonymity, we use the terms Suburb-Large and City-Large by IES and NCES (n.d.) to name the participating school districts. Because a goal of the larger project is recruiting and retaining engineering majors to teach at high needs schools, schools were chosen that fit this definition (See Table 1 for participant district demographics).

Table 1 Demographics of District Partners

| District | # of<br>Students | Race/Ethnicity |       |       |                   |                                | Title I<br>Designation |
|----------|------------------|----------------|-------|-------|-------------------|--------------------------------|------------------------|
|          |                  | Hispanic       | Black | White | Asian or<br>Asian | Native<br>American<br>& two or |                        |

|                  |         |     |     |     | Pacific<br>Islander | more<br>races |   |
|------------------|---------|-----|-----|-----|---------------------|---------------|---|
| Suburb-La<br>rge | 41,000  | 54% | 25% | 17% | 2%                  | 2%            | X |
| City-Large       | 53, 952 | 27% | 13% | 32% | 24%                 | 4%            | X |

## Results

Both programs for new teachers belong to a two-year induction program. The Suburb-Large mentoring program focuses on the responsibilities of new teachers, while the City-Large focuses on the responsibilities of the mentors. As a result, the discussion below describes first the responsibilities of the mentors followed by the discussion of the responsibilities of the new teachers.

City-Large has mentoring programs for novice teachers and new teachers in the district. For the purposes of this paper, the focus is on novice teachers with less than two years of experience. There is a lead mentor for each campus and mentors of novices. Mentors of novices may have up to five new teachers and meet with them individually and in groups. Six to eight hours is the expectation for meeting with mentees in year one and three to four hours in year two. This time can occur during or after school hours. Mentors receive a stipend and are not necessarily in the same subject area. The district looks for mentors who are active learners, supportive, and effective communicators. New teachers are encouraged to also have a teacher in their subject area but not assigned by the district or campus. Mentors provide instructional support such as learner-centered approaches; support of logistics of the classroom and technology; and provide emotional support both initiated and not initiated.

The suburb-large describes mentoring support at the district and campus levels. The district level specifies expectations for the new teachers. Year-1 focuses on professional development (PD) provided while year-2 allows new teachers to select from a menu of PD opportunities within the district. Year-1 begins in the summer with a new teacher seminar followed by two-hour sessions each month (four in the fall and two in the spring). Each month has a different focus with one of the months focused on subject-specific sessions. The district provides new teachers with a website for access to resources such as district policies, electronic resources, and cheat sheet to commonly used acronyms. One of the electronic resources provides short 90-second videos created by the district.

One of these includes the importance of greeting your students with a smile and knowing and pronouncing your students by their chosen names at the beginning of the school year.

At the campus level, new teachers receive mentoring from the campus mentor and an assigned mentor. The campus mentor is responsible for supporting all new teachers and implementing resources supplied by the PD department. First-year teachers have an assigned mentor who is paid for mentoring and provides ongoing support and receives resources from the PD department. Each assigned mentor has only one mentee. The new teacher mentor characteristics are like the City-Large new teacher mentors who are effective teachers in the classroom, active learners, supportive of peers, and good with communication. While there is no expectation of time to spend with the mentee, the mentor must document at least 10 conversations over the course of a year. Also, the new teacher mentors and mentees are expected to observe each other in the classroom and debrief after each observation. The district provides a substitute for this to occur. (For a summary of comparisons between literature and districts see Table 2 below.)

Table 2

*Comparison of District Induction Programs with Induction Practices Recommended by Literature*

| Induction Practices in Literature            | Suburb-Large District                                                                                                                                     | City-Large District                                                                |
|----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| Subject Specific Mentors                     | *Have campus mentor along with personal mentor<br>*Personal mentor must meet at least 10 times with mentee<br>*Not a guarantee of subject-specific mentor | May share mentor with up to 5 mentees<br>(Not necessarily subject-specific mentor) |
| Common Planning Time with Mentor             | -                                                                                                                                                         | -                                                                                  |
| Faculty Lead PLCs                            | Modeled strategies, techniques and resources presented in PLCs                                                                                            | Professional learning Dept offers "New Teacher Labs"                               |
| Communication with campus administration     | Campus Mentor Liaisons                                                                                                                                    | -                                                                                  |
| Opportunities to Communicate with Colleagues | -                                                                                                                                                         | -                                                                                  |
| Reduction in Teaching Load                   | -                                                                                                                                                         | -                                                                                  |
| Beginner Seminars or Videos                  | *Professional development offered within district 1-2 hour session monthly<br>*Offers resource website                                                    | Offers New teachers 1-hour sessions every other month                              |
| Mentoring overlap between student            | -                                                                                                                                                         | -                                                                                  |

|                                         |  |  |
|-----------------------------------------|--|--|
| teaching phase and<br>new teacher phase |  |  |
|-----------------------------------------|--|--|

### Discussion

Both districts have a comprehensive induction program with the City-Large focused on expectations of mentors and the Suburb-Large more focused on new teacher expectations. Aspects of both programs include some of the research-based best practices of strong induction programs.

Both had administrators at the campus level who were also mentors called lead mentors (Ingersoll, 2012; Wynn et al, 2007). In addition, the Suburb-Large also had district seminars and websites to support new teachers. Neither district provided a teacher aide or reduced teaching load or schedule as suggested by Kearney (2017).

The City-Large expectation of time with mentees included a max of eight hours in year one and four hours in year two during or after school hours. This is in stark contrast to what ndunda and colleagues (2017) describe as meeting 1-2 hours a week after school or on Saturday. Suburb-Large did not describe the amount of time the new teacher mentor was to spend with mentees but did include observations in both the mentor and mentee's classrooms with debriefings after each, which was like ndunda and colleagues (2017).

The subject-specific mentors were described as one of the essential characteristics of a mentor (McConnell, 2017; Morrell & Salomone, 2017; ndunda et al., 2017; Smith & Ingersoll, 2004). However, only City-Large mentions a subject-specific mentor and the mentee must seek out this person on their own. The City-Large did provide mentors to meet with their mentees in groups which could encourage collaboration with each other (Ingersoll, 2012).

### Implications

We were able to collect information from partner school districts regarding their induction programs and related articles about best practices for induction programs. City-Large was focused on the responsibilities of the mentors and Suburb-Large was focused more on the mentees. Because district partners typically have only one engineering teacher per campus, identifying a subject specific mentor is not always possible. Some areas that the university and district partners could build on these initial findings include expectations for both mentors and mentees, subject matter mentors, and opportunities for STEM mentees to collaborate.

Our plan is to build on these initial findings of school district induction programs and design a supplemental induction program for STEM Teachers. We took this information to our partner

school districts to identify with them what is wanted for the supplemental induction program. At the time of this article there was concern for both mentors and mentees to provide financial support for the mentor and mentee relationship rather than the expectations. We discussed initially finding grant funding to support mentor and mentee stipends. The reason is that most of this work happens outside the school day and we should value the additional time expected of them.

As a university, we need to consider how to provide university engineering mentors to new STEM teachers (ndunda et al., 2017). As the districts do not always have two or more engineering teachers on a campus, they are unable to provide a subject specific mentor. Our district partners agree that a supplemental induction program containing robust mentoring that includes university engineering faculty to serve as the subject specific mentor is essential.

Lastly, opportunities should be provided for STEM mentees to collaborate for social and peer support (Grier & Johnson, 2009; Koehler et al., 2013). Our district partners sighted that the supplemental induction program include both virtual and face-to-face meetings. The face-to-face meetings should take place in a common meeting place such as a coffee house to collaborate, socialize, and do book studies. By building the capacity to support engineering majors to be STEM teachers, we will be able to support their professional needs while also building a pipeline for future students especially those underrepresented to excel in STEM education.

### References

- Bischoff, P., French, P., & Schaumlöffel, J. (2014). Reflective Pathways: Analysis of an Urban Science Teaching Field Experience on Noyce Scholar-Science Education Awardees' Decisions to Teach Science in a High-Need New York City School. *School Science and Mathematics*, 114(1), 40-49. <https://doi.org/10.1111/ssm.12057>
- Grier, J. M., & Johnston, C. C. (2009). An inquiry into the development of teacher identities in STEM career changers. *Journal of Science Teacher Education*, 20(1), 57-75.
- Hansen, M., & Quintero, D. (2018). *Can states lean on diverse teacher recruitment to stem teacher shortages?* Brown Center Chalkboard. <https://www.brookings.edu/blog/brown-center-chalkboard/2018/01/17/can-states-lean-on-diverse-teacher-recruitment-to-stem-teacher-shortages/>
- Ingersoll, R. (2012). Beginning teacher induction: What the data tell us. *Phi Delta Kappan*, 93, 47-51. <https://dx.doi.org/10.1177/003172171209300811>
- Ingersoll, R., & Smith, T. M. (2004). Do teacher induction and mentoring matter? *NASSP Bulletin*, 88(638), 28-40.
- Institute of Educational Sciences, & National Center for Education Statistics. (n.d.). Education demographics and geographic estimates. <https://nces.ed.gov/programs/edge/Geographic/LocaleBoundaries>
- Kearney, S. (2017). Beginning teacher induction in secondary schools: A best practice case study. *Educational Research*, 27(4), 784-802.

- Koehler, A. A., Feldhaus, C. R., Fernandez, E., & Hundley, S. (2013). STEM alternative certification programs & pre-service teacher preparedness. *Journal of STEM Education: Innovations and Research*, 14(4), 44-55.
- McConnell III, J. R. (2017). A model for understanding teachers' intentions to remain in STEM education. *International Journal of STEM Education* 4(1), 1-21.  
<https://doi.org/10.1186/s40594-017-0061-8>
- Morrell, P. D., & Salomone, S. (2017). Impact of a Robert Noyce scholarship on STEM teacher recruitment. *Journal of College Science Teaching*, 47(2), 16-21.  
[https://doi.org/10.2505/4/jcst17\\_047\\_02\\_16](https://doi.org/10.2505/4/jcst17_047_02_16)
- ndunda, m., Van Sickle, M., Perry, L., & Capelloni, A. (2017). University-urban high school partnership: Math and science professional learning communities. *School Science and Mathematics*, 117(3-4), 137-145. <https://doi.org/10.1111/ssm.12215>
- Smith, T. M., & Ingersoll, R. M. (2004). What are the Effects of induction and mentoring on beginning teacher turnover? *American Education Research Journal*, 41(3), 681-714.
- Thompson, J., Windschitl, M., & Braaten, M. (2013). Developing a theory of ambitious early-career teacher practice. *American Educational Research Journal*, 50(3), 574-615.
- Wong, S. S., & Luft, J. A. (2015). Secondary science teachers' beliefs and persistence: A longitudinal mixed-methods study. *Journal of Science Teacher Education*, 26(7), 619-645.
- Wynn, S. R., Carboni, L. W., & Patall, E. A. (2007). Beginning teachers' perceptions of mentoring, climate, and leadership: Promoting retention through a learning communities' perspective. *Leadership and Policy in Schools*, 6, 209-229.

### Acknowledgments

This material is based upon work supported by the National Science Foundation under Grant No. 2149596. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.