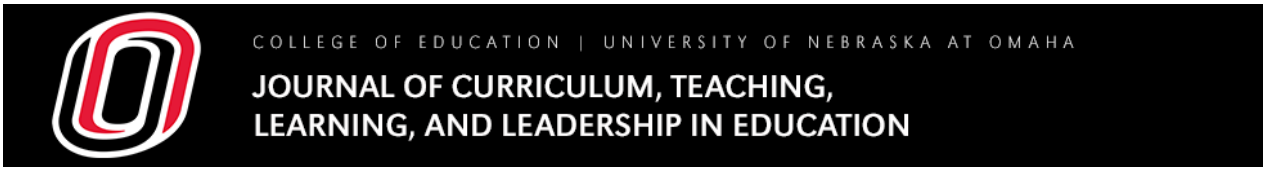

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Reflection, Growth, and Mentoring of Beginning Science and Mathematics Teachers

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REFLECTION, GROWTH, AND MENTORING OF BEGINNING SCIENCE AND MATHEMATICS TEACHERS

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Abstract: *This is a qualitative study of beginning science and mathematics teachers involved in a comprehensive teacher induction program. The teacher induction program was striving to encourage and increase the reflection of the beginning teachers in their program. A formal reflection instrument (Plus/Delta) was used to assist the beginning science and mathematics teachers reflect on specific lessons and compare their Plus/Delta results with those of their mentors. This study compares and where appropriate, quantifies the results of both the beginning teachers and their mentors. There were six themes found in the data reported by both mentors and beginning teachers. The themes include: management, student engagement, differentiation, assessment, instruction, and preparation. The results show agreement among mentors and beginning teachers in the area identified as needing the most change. Mathematics teachers and mentors stated that student engagement was the most reported area needing change, while science mentors and beginning science teachers found management to be the most reported area needing change.*

Introduction

Research completed to date confirms that beginning science and mathematics teachers face many challenges, and must master numerous areas of teaching proficiencies in order to demonstrate competence in teaching (EunJin, Kern, Luft, & Reohrig, 2007). Luft (2003) reports that fewer than 20% of mathematics and science teachers have access to mentoring or induction programs of any kind. Most beginning math and science teachers will face the initial year of practice with little or no access to an induction program targeting their content areas (Luft, 2009). Research further suggests that science and math teachers left without critically needed guidance, a comprehensive induction program could provide, often develop practices that do not allow their students to participate in inquiry activities (e.g. labs, simulations, problem solving, research projects (Luft, Roehrig, & Patterson, 2003). Instead the beginning science and math teachers persist with teacher centered teaching strategies (e.g. lecture, presentation, recitations) that may not be effective or engaging to their students. Further, helping beginning science and mathematics teachers to reach higher levels of teaching competence is shown to be possible and very effective through comprehensive induction programs of mentoring (Gilles, Davis, McGlamery, 2009; Simmons et al, 1999; Luft, 2009).

The focus of this paper is to chronicle the efforts of a comprehensive teacher induction program as it tries to build beginning science and mathematics teachers' knowledge, skills and dispositions. Further, this research explores the implementation of a systematic reflection process that allows mentors to provide feedback on the beginning teachers' knowledge, skills and dispositions using the Plus/Delta instrument. The responses/reflections of both the mentors and beginning science and mathematics teachers are compared to see what areas of concern and success each reports after observing and reflecting on science or math lessons taught by the beginning teachers.

Literature Review

Many articles have discussed the looming teacher shortage that our nation will be facing in the next decade. The National Center for Education Statistics (NCES, 2011) reported that between the fall of 2008 (the last year of

actual public school data) and the fall of 2020, the number of qualified teachers needed in elementary, middle and secondary schools is projected to rise. The projected shortage has been brought on by the growing enrollment of students, teacher retirement, as well as teachers exiting classrooms due to high-stakes testing. Teachers of science and mathematics are no exception to the trend. Their numbers are unstable because of rising attrition rates. For example, national statistics show the attrition rate out of teaching for mathematics and science teachers is 50% within 3 years of the start of their teaching careers (NCES, 2011).

In order to stem the tide of attrition out of teaching, reformers and policy-makers have called for induction programs for beginning teachers. "The first years of teaching are an intense and formative time in learning to teach, influencing not only whether people remain in teaching but what kind of teacher they become" (Feiman-Nemser, 2001, p. 1026). Professionals have documented and argued that key factors in retaining beginning teachers are related to high-quality preparation, induction, as well as comprehensive mentoring programs (Berry & Hirsh (2005); Darling-Hammond (1997b); & Johnson & Birkeland (2003). Luft (2009) takes it a step further to suggest that science and mathematics teachers need not only a comprehensive program, but one focused on the needs of the content specialist.

As early as the 1980's educators identified the need to support the philosophical, professional and pedagogical needs of beginning teachers. During the past two decades a large body of research has been conducted on the benefits of mentoring and induction programs for beginning elementary, middle level, and secondary teachers. "Mentoring" refers to a master teacher providing the novice teacher with one-on-one assistance. "Induction" refers to a more comprehensive program to include expertly trained mentors that guide novices with content-specific needs, assistance in filling in gaps with content (knowledge), as well as management and assessment tools (skills). Teacher induction is the process of supporting the work of beginning teachers so that they adjust well (dispositions) into the new teaching environment and social system of the school, understand their responsibilities, and become professionally competent as quickly as possible (Gilles, Davis, & McGlamery, 2009; Gregory, 1998; Tisher, 1982; McDonald, 1980, Evey, 1956).

Across the literature it has been documented that the induction needs of secondary teachers vary from their elementary colleagues (Luft, 2009). Content needs are varied among new secondary teachers. Secondary teachers need to be proficient in their academic disciplines, have knowledge of how to differentiate curriculum to reach all students, as well as knowledge of a how to effectively manage and assess student learning (EunJin, Kern, Luft, Roehrig, 2007). "Induction, done well, has the potential to act as a professional incubating system that cultivates excellence among this country's secondary teachers" (Gschwend & Moir, 2007, p. 2).

To address the needs of beginning teachers, higher education has collaborated with school districts to design induction programs with mentoring support for the first year of teaching. Gold (1996) reported that programs for beginning teachers influenced their retention. A critical component of effective on-site induction programs is mentoring.

Research literature supports that quality teacher induction programs include particular components. Gschwend & Moir (2007) identified nine key components that most effective induction programs use a comprehensive system of support are marked by: (1) high-quality, carefully selected mentors; (2) expertly trained, fully released mentors; (3) authentic mentoring processes where teachers routinely reflect on their practices as measured against teaching standards; (4) rigorous and comprehensive use of an effective, research-based, formative assessment system; (5) a standards-based seminar series for new teachers; (6) collaborative inquiry; (7) district/site/professional partnerships; (8) supportive working conditions, including realistic workloads; and (9) administrative support (p. 21).

Mentoring is one component of quality teacher induction programs. The mentor is a teacher, advisor, sponsor, guide, coach, and confidante (Daloz, 1986; Kram, 1983; Ostroff & Kozlowski, 1993). In the California Mentor Teacher Program, for example, mentors represent an outstanding group of teachers who have the training and expertise necessary to help newcomers (Schulman & Colbert, 1985). Beginning-teacher induction programs with mentors in key roles refers to a planned program intended to provide systematic and sustained assistance, specifically to beginning teachers for at least one school year (Huling-Austin, 1990).

Investigations into mentoring indicate numerous benefits for the new teacher, as well as for the veteran teacher (Cochran-Smith, 1991; Feiman-Nemser et al., 1993). For example, Fox & Singletary (1986) found that successful assistance provides "new teachers with skills that will assist them in developing methods for problem-solving and transferring the theories learned in preservice training to appropriate teaching practices" (p. 14). By promoting observation and conversation about teaching, mentoring is believed to help teachers develop tools for reflection on and continuous improvement of teaching practice.

According to the literature, beginning teachers progress through various stages of development (Darling-Hammond & Bransford, 2005; Feiman-Nemser, 2001). As beginning teachers move through the various stages of

development, their thinking about teaching becomes more complex and reflective, thus informing their teaching practices. How can we influence this reflection? How about the mentoring of science and mathematics teachers, are their concerns the same as other beginning teachers?

Research Setting

This paper focuses on research conducted with the CADRE Project at the University of Nebraska at Omaha. The CADRE Project is a collaborative teacher induction effort between higher education and K-12 practitioners. The Metropolitan Omaha Educational Consortium (MOEC), comprised of the 12 metropolitan Omaha public school districts and the University of Nebraska at Omaha College of Education, coordinates this project. This project is a true collaborative effort involving public school superintendents, university administrators and faculty and staff from both entities. The acronym CADRE refers to the overriding goal of Career Advancement and Development for Recruits and Experienced Teachers, and the project creates a framework of growth and development within the teaching profession; thus building a CADRE of outstanding teachers.

The project, which began in 1994, provides a yearlong teaching experience for newly certified teachers who are also completing a specially designed master's degree program. The structured first year teaching experience includes a broad variety of professional learning experiences designed to assist CADRE teachers in reaching a level of professional skill and judgment that characterizes a well-qualified teacher.

This experience provides practical teaching techniques and strategies, along with feedback on the classroom application of teaching strategies. The CADRE teacher has access to formal mentoring, as well as, graduate work focusing on the synthesis of various learning theories. The project also provides opportunities for veteran classroom teachers, CADRE Associates. The CADRE Associates are master teachers selected by their respective districts to serve in this role for two to three year period. They assume alternative responsibilities, which include mentoring two of the CADRE teachers, district-designated roles, and university related work.

Linking beginning teachers to veteran master teachers while incorporating university coursework specifically targeted to first year teachers' needs, collaborative inquiry, professional conversation with peers and mentors, and reflection about teaching experience, has proved to be a powerful combination. It is not enough just to bring a novice and experienced teacher together. Effective induction of beginning teachers must be linked to a vision of good teaching, guided by an understanding of teacher learning, and supported by a professional culture that favors collaboration and inquiry.

Methodology

Purpose of the Study. The goal of our research was to examine the perceptions of teaching practice early in the induction program and again at the conclusion of the induction program of first year science and mathematics teachers. Essential to new science and mathematics teacher development is the ability for the new teacher and mentor to engage in reflective dialogue about the teaching and learning experience as well as the ability for the mentor to know and understand the teaching and learning situation from the perspective of the new teacher. This study provided opportunity to examine the reflections and perceptions of both the beginning teachers and their mentors at key intervals in the induction program.

Study Participants. The study followed 12 mathematics and 12 science teachers during their first year of teaching practice.
Also during this first year of teaching these 24 science and mathematics teachers were, at the time of the study, participating in the CADRE Teacher Induction Project. The CADRE Project provided the new teachers with a year-long induction experience and a mentor teacher assigned to assist them in their classrooms.

Research Questions. We examined the reflections completed by the beginning teacher (BT)-mentor pairs. The reflections were focused on teaching experiences in the fall and we compared it to the reflections on teaching experiences the following spring of the beginning teachers' first academic year. Specifically, we addressed the following questions:

1. What did beginning science and math teachers perceive as going well in the observed lessons?

2. What did mentor teachers perceive as going well in the observed lessons?
3. What did beginning science and math teachers perceive as areas for change/ and goals for change?
4. What did mentor teachers perceive as areas for change/ and goals for change?
5. Was the Plus /Delta useful to beginning science and mathematics teachers and their mentors? If so, how or why? If not, why not?

The purpose of this paper is to report the findings of this Plus/Delta instrument used to assist beginning science and mathematics teachers and their mentors examine teaching experiences and discuss practice and set goals for future growth.

Study Plus/Delta Methodology. The data examined included all beginning mathematics and science teachers participating in the CADRE Induction Program from 2007 to 2013. The reflections of the first teaching experiences were gathered using The Plus/Delta. These reflections occurred in the fall of the teacher's first year and again in the spring of that academic year for all years. Each BT (Beginning Teacher) and mentor pair recorded what went well and suggestions for change regarding lessons during the fall and again during the following spring. These observations were recorded immediately after a lesson as written comments on a one-page Plus/Delta Chart. Items recorded in the Plus section of the chart indicated what went well and items recorded in the Delta section of the chart indicated a suggestion for change. After the BT and mentors shared and discussed their comments, the BT wrote a goal at the bottom of the chart.

In the fall and spring, all the written comments were read and re-read separately by two researchers. The researchers used constant-comparative analysis to identify categories of similar comments and devise rules that described the properties of each category. (Glaser & Strauss, 1965; Goetz & LeCompton, 1981; Lincoln & Guba, 1985; Bogdan & Biklen, 2007)). Each researcher attached a descriptive label to each of the categories. The comments were then re-read individually to make sure each comment was included in one of the categories we each individually identified. Then the two researchers met together to compare how each had categorized all the comments.

The researchers found they had indentified six similar categories which were: a) management, b) student engagement, c) instruction, d) assessment, e) preparation, and f) differentiation. The researchers agreed upon the properties for all but the "instruction" category. The "instruction" was too broad to clearly identify comments. So the researchers then re-read the relevant coded comments in order to refine and re-label the "instruction" category. The defining properties became more limited and it was labeled the "teacher input" category. Complete agreement was then reached as to the labels and properties of all six categories. Agreement was also reached as to how to categorize each of the mentor and beginning teacher comments within the categories.

Each semester the analysis was repeated. All the written comments were read and re-read and categorized using the same categorization scheme determined the previous fall. The comments fit into the same categories except for specific teaching strategies such as: a) singing, b) utilizing the SMART Board, and c) power teaching. During the spring of 2009, three of the researchers met to review the data. We agreed to combine the comments on "teaching strategies" with the comments on "teacher input" and re-labeled all such comments under the category of "instruction." We re-instated the category of "instruction." We reached consensus that instruction included teacher input and teaching strategies. Agreement was re-affirmed as to the labels and properties of all categories.

Using the categories, frequency counts were made for both fall and spring to determine the number of lessons during which each area (category) was noted by either beginning teacher or by mentor. Frequencies were tallied for "What went well" and for "Suggestions for change."

Plus/Delta Findings

Qualitative analysis resulted in the following six categories: a) Student Engagement, b) Management, c) Instruction, d) Preparation, e) Assessment, and f) Differentiation.

Student Engagement was defined as students mentally engaged in the learning process. It included incorporating activities demonstrating higher level thinking, making connections with students, building upon prior knowledge, providing appropriate review, motivating students to engage in the learning process, recognizing evidence of student understanding/learning, and engaging all students in a lesson by giving them an opportunity to participate.

Management included class and time management, as well as self-management. Class/time management included pacing, movement, teacher/student transitions, alternate activities for early finishers, clearly defined routines, grouping students, using student names, and utilizing a paraprofessional.

Self-management included the teacher remaining calm, confident, enthusiastic, articulating expectations of the students, and establishing student rapport.

Instruction included both teacher input and teaching strategies. Teacher input included teacher modeling, use of materials, providing explanation/directions to include visuals, as well as providing examples or posting directions on the board before students began seatwork.

Teaching strategies included specific activities such as labs, using the SMART Board, the Elmo projector, showing a video, integration of manipulatives, power teaching, and other science activities.

Preparation included the teacher demonstrating an organized lesson, stating clear objectives, as well as a lesson that integrated a variety of activities.

Assessment included the teacher's ability to use student response to formulate and give feedback or provide specific praise during questioning. Assessment also included the teacher's demonstration of wait time, appropriate work time, the teacher walking around, and/or providing learning opportunities that included feedback to students and/or guided practice.

Differentiation included lessons that were appropriately planned, lessons prepared in advance for struggling to advanced learners, lessons that included student-centered decision-making, and/or working one-on-one with students, or self- paced stratified lessons taking into account different learning styles.

All of the data presented in the following sections are summarized in charts located in Appendices A, B, C and D.

Areas Most Often Mentioned as Going Well

Fall

Beginning Science Teachers' Perspectives

The beginning science teachers overwhelmingly focused on student engagement and management followed by preparation, instruction and assessment. These areas form the main areas of teaching skill the beginning science teacher reported as going well in the identified lessons.

The beginning mathematics teachers focused on management with instruction a close second. Student engagement was third and assessment, differentiation and preparation were mentioned less frequently as going well.

Mentors' Perspectives

Mentors of the science teachers also focused on student engagement and management as their top two areas identified as going well. But they depart from the beginning science teacher by mentioning assessment of student learning as a third area going well. Instruction was fourth, followed by preparation and differentiation

Mentors of mathematics teachers also focused on management, but to a greater degree than their mentees. Student engagement was second, followed by assessment, instruction, preparation and differentiation.

Spring

Beginning Teachers' Perspectives

In the spring the beginning science teachers focused on student engagement, instruction and assessment in about equal emphasis. Most districts are focused on state and districts assessments in the spring and this may account for the attention given instruction and assessment. Management fades to fourth and differentiation and preparation are mentioned less frequently.

Mentors' perspectives

Mentors of the science teachers still focused on student engagement and instruction as their top two areas with management a close third. Assessment was fourth on the list followed by preparation and differentiation.

Differences Between Mathematics and Science Teachers

For the beginning science teachers and their mentors the top two most frequently mentioned items as going well were student engagement and management. These areas have shown to be major areas of concern for beginning teachers as they are initially establishing classroom management systems and developing lessons and labs that hopefully engage students.

For the beginning mathematics teachers and their mentors the top two areas most frequently mentioned as going well were management for both BMT (beginning math teachers) and mentors. The second category was instruction for BMT and student engagement for the mentors.

Areas Most Often Mentioned as Challenging or Needing Change

Fall

Beginning Teachers' Perspectives

For the beginning science teachers, classroom management was the most challenging area of teaching needing the most change. Second was student engagement followed by instruction, assessment, differentiation and preparation.

Mentors' Perpectives

Mentors of science teachers agreed with their mentees placing management as the clear number one area for change. Management was followed by student engagement, instruction, assessment, preparation and differentiation

Spring

Beginning Teachers' Perspectives

Management is still a concern, but not to the degree expressed in the fall. Student engagement is second and differentiation is now third on the list of areas needing change. Assessment instruction and preparation are further down the list of concerns.

Mentors' Perspectives

Mentors of science teachers agreed with the beginning teachers and list management as their primary concern followed by student engagement. The mentors select assessment practices as needing change. Followed by instruction, differentiation and very few mention preparation as still a concern.

Insert Appendices A-D Here

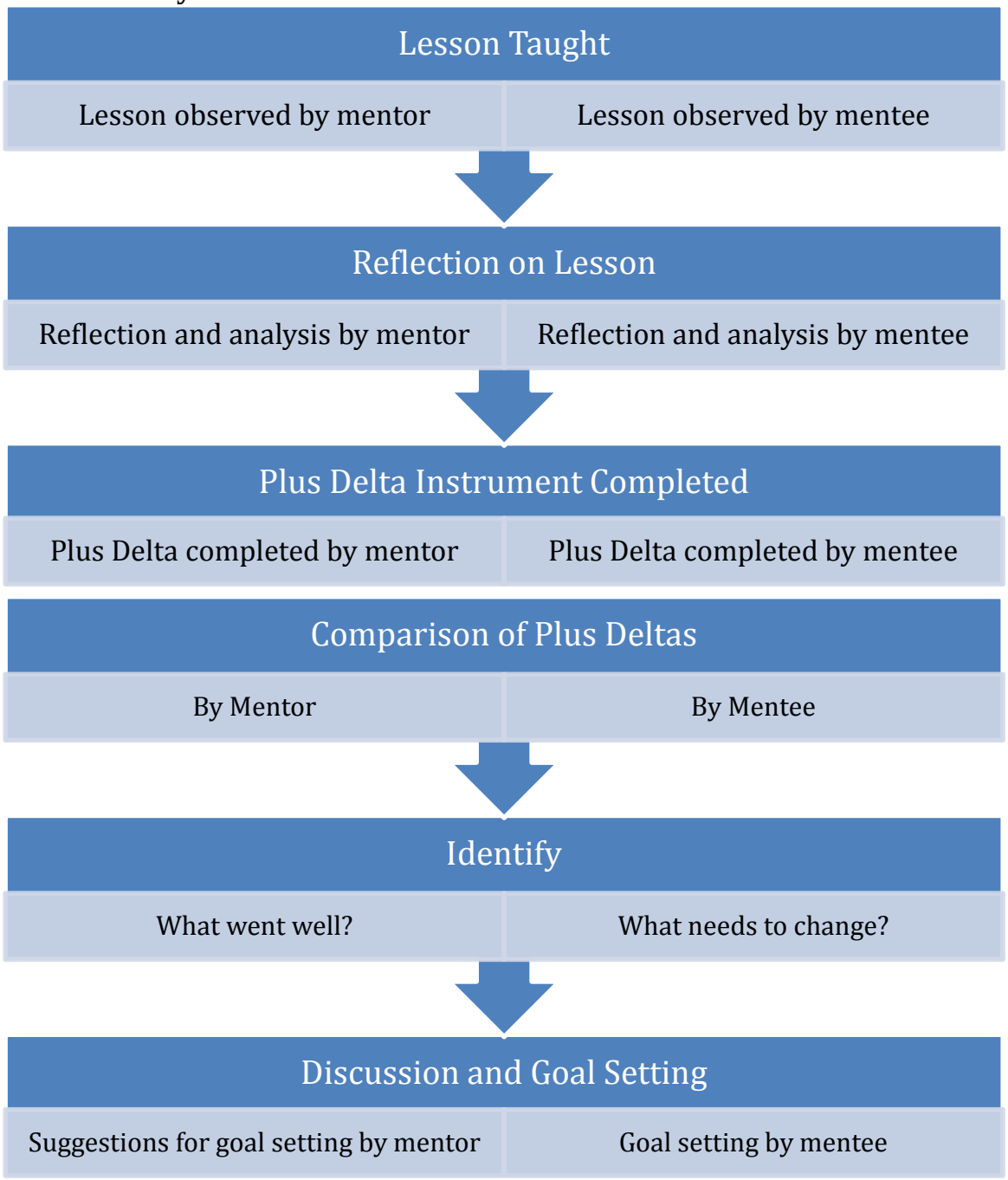
Differences between Science and Mathematics teachers

The science mentors and beginning science teachers found the area needing the most change was classroom management. In terms of areas needing change both mentors and beginning mathematics teachers mentioned student engagement as the number one area of concern.

Reflection Cycle Observed in the Plus Delta Sessions

Both the mentor and mentee found the observation and analysis of the lessons helpful. The process was cyclic and involved observation, reflection, discussion, and goal setting.

Reflection Cycle Plus/Delta



Discussion

Mathematics and science teachers have some of the same concerns but in different order of priority. The concerns were expressed by both mentors and beginning teachers. Mentor 1 expressed her experience assisting her mentee as follows: "Jason had some of the same concerns as the other science teachers. He lacked some skill in

managing the labs, so we looked at some options and he set some instructional goals. The sessions were very helpful." Both mentors and beginning teachers agreed on the areas needing the most work.

Beginning teachers need help focusing on their practice. They have so many distractions and demands on their time. The mentors and beginning teachers report the usefulness of the Plus/Delta reflections. "I really have trouble getting time to think about my teaching…the students start coming in and it's so hard to have time to think about how I need to address a problem or rework a lab." (Science Teacher, 8)

Beginning teachers need assistance reflecting on their practice and setting realistic goals. One beginning math teacher stated: "My mentor was very helpful and supportive of the goals I wanted to pursue. She advised me on some strategies I might consider and how to best go about making the changes in my teaching I wanted to make." (Mathematics Teacher, 11) The reflective exercise was helpful in providing focus and direction to the beginning math and science teachers.

Science and mathematics teachers looked at two different areas for change. The beginning science teachers focused on *management,* while the beginning mathematics teachers focused on *student engagement*. These differences may be attributed to the nature of the subjects and the needs of the specific content areas.

For example, mathematics teachers often focus on problem solving which requires students to focus on the task at hand for extended periods. Often this task focus demands more strategies for sustained student engagement.

In science, the engagement issues are not as pressing. Most students readily engage in labs and activities required in learning science. The issues arise when trying to manage labs and activities that use equipment and require the use of chemical reagents and flames. Management issues remained, even to the end of the year for most of our beginning science teachers.

Conclusions and Implications

Impact on the Program. What do we know about what works for beginning science and mathematics teachers?

The beginning teachers need to have a mentor in their field whether science or mathematics.

The content specific issues raised during the Plus/ Delta sessions about how to teach specific content and what activities, labs, and pedagogy to use demonstrates why content familiar mentors are most useful. BT brought up the questions posed by their students, for example, "When will I ever use this information? or Why do we have to learn this? or When in real life will I see this used"? All valid questions needing to be addressed. This is best dealt with by a content savvy mentor who can assist his or her mentee in responding appropriately.

Beginning teachers need to be given support to reflect on practice.

Increasing the reflection time shortens the time needed to identify areas of improvement and begin working on them. All the mentor teachers agreed that more reflection and discussion about teaching and learning issues brought out the issues faster and expedited the changes in practice put in place by the beginning teachers.

Beginning teachers need to know that change takes time and effort.

"BT's believe that perhaps change comes quickly. When they find resistance in their students and discomfort in themselves they tend to recoil from change. Having a mentor who can reassure them that change takes time is helpful." (Mentor Teacher, 6)

Positive feedback from mentors is essential to teacher growth.

"Professional development is work and we all need encouragement to stay with it." (Mentor Teacher, 7) The mentors found the Plus part of the Plus/Delta to be a great place to encourage their mentees' efforts and to acknowledge their strengths as teachers. It also provided a venue for the beginning teachers to learn to realistically evaluate their own performance in the classroom.

Suggestions for change/feedback must be targeted and constructive when given.

Mentors reported that a detailed plan of strategy is most helpful to the beginning teacher. Mentors must avoid comments like " tighten up the discipline." Preferring instead to give beginning teachers specific instructions about how to accomplish a task, mentors found the direct and specific approach to be best. Further, mentors noted: "The more input the beginning teacher has in the goal setting and planning process, the better the result. The full participation of the beginning teacher is the best way to assure progress." (Mentor Teacher, 4) Further, the mentors agreed that too much negative feedback can overwhelm the beginning teachers and cause them to lose motivation and give up. Both mathematics and science mentors agreed that with the Plus/Delta, it is better to pick the top two areas for improvement and start there.

"Many beginning math teachers struggle with student engagement, management and differentiation, and many other things. But, it is just too much to address everything at once, pick two areas, or just one. Start with

encouragement and move to one suggestion, discuss it and make a goal that is short term, immediate and doable in the next few weeks. Come back and discuss the results of the instructional change…do this often…. and you will see progress. It's the incremental growth of teaching skill the Plus/Delta supports through reflection and goal setting." (Mentor Teacher, 5)

The data supports the need for teacher induction programs to increase the opportunities for beginning science and mathematics teachers to reflect on their teaching and discuss setting goals.

Reflection done regularly will increase the rate of professional growth. "The more times we used Plus/Delta, the more progress my mentee made. Sometimes it is hard to take the time during the school day to sit down and reflect on practice…most times it doesn't happen. But when we did take the time to teach and reflect, things came up, it started conversations that needed to happen." (Mentor Teacher, 2)

"I needed the time with my mentor to help me decide how to teach the math concepts coming up. We not only talked about the current lesson I reflected on, but on what I should do next. Goal setting assisted me in plotting a course toward improvement." (Mathematics Teacher, 7)

The reflection done with plus/delta increases the ability of the mentor to have or address difficult areas.

The conversation was started during a plus /delta session and often ended with an instructional goal being set. The mentors agreed that the use of the Plus/Delta instrument after observing their mentee teacher teach gave more opportunity for discussion and resulted in more growth.

"I personally found the Plus/Delta sessions with my mentor very useful and helpful. We had the opportunity to discuss in depth my strengths as a teacher. Also, the teaching skills I needed to address we discussed. There was no pressure to agree, we just talked out a strategy, maybe a new way of presenting the material I hadn't considered. We had a formal time to do this…a time for really reflecting on practice. It was very beneficial for me." (Science Teacher, 9)

"The opportunity to reflect together made the difference for me and my mentee. The Plus /Delta opened the door to discuss areas of teaching my mentee wasn't sure about. She wanted to talk about the inquiry lab that didn't go as planned. We had a reason to stop and reflect…and she wasn't being singled out, everyone in CADRE was doing a Plus/Delta. It lowers the stress and allows the mentor-mentee to just talk about practice and discuss issues, set goals and move on." (Mentor Teacher, 4)

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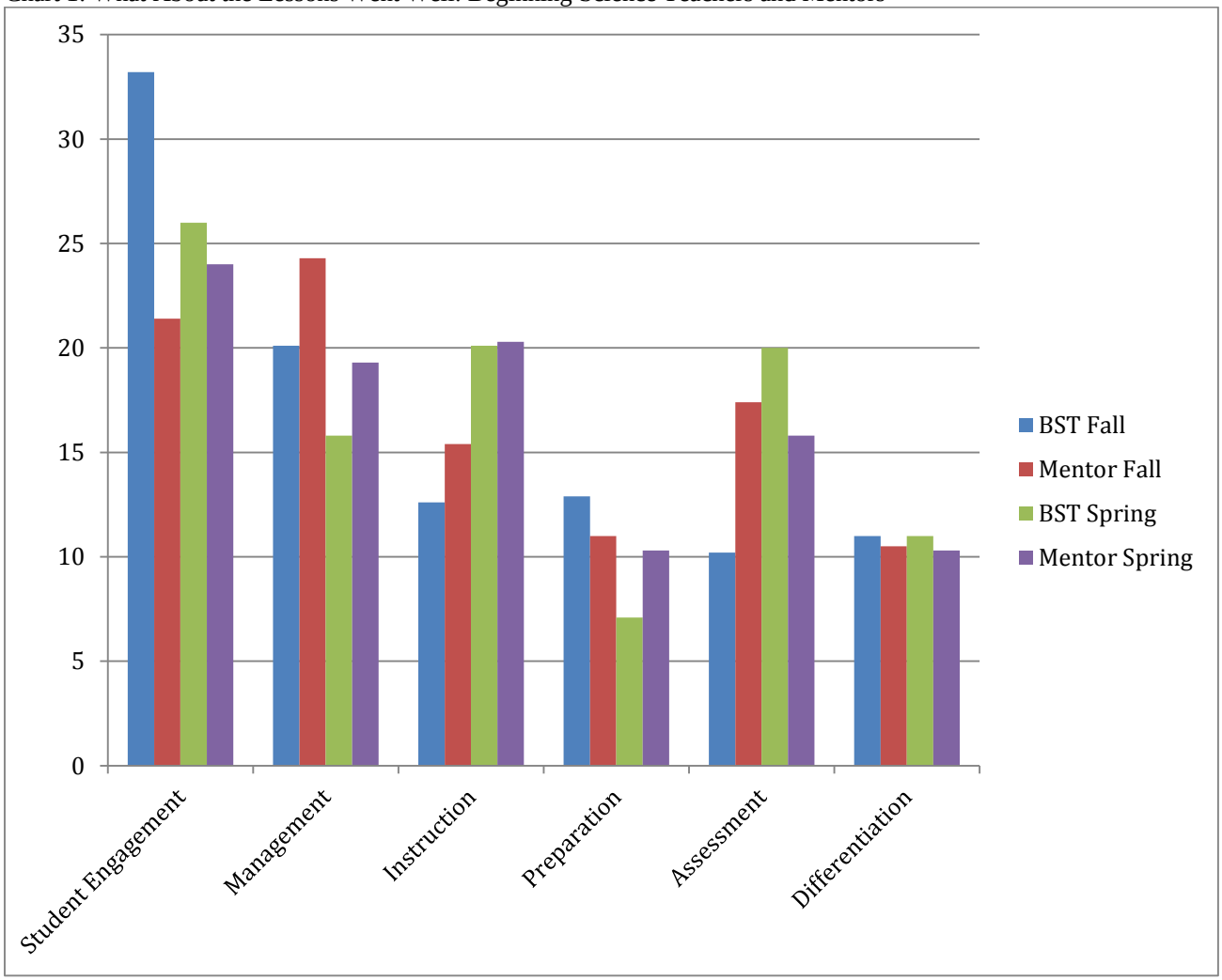
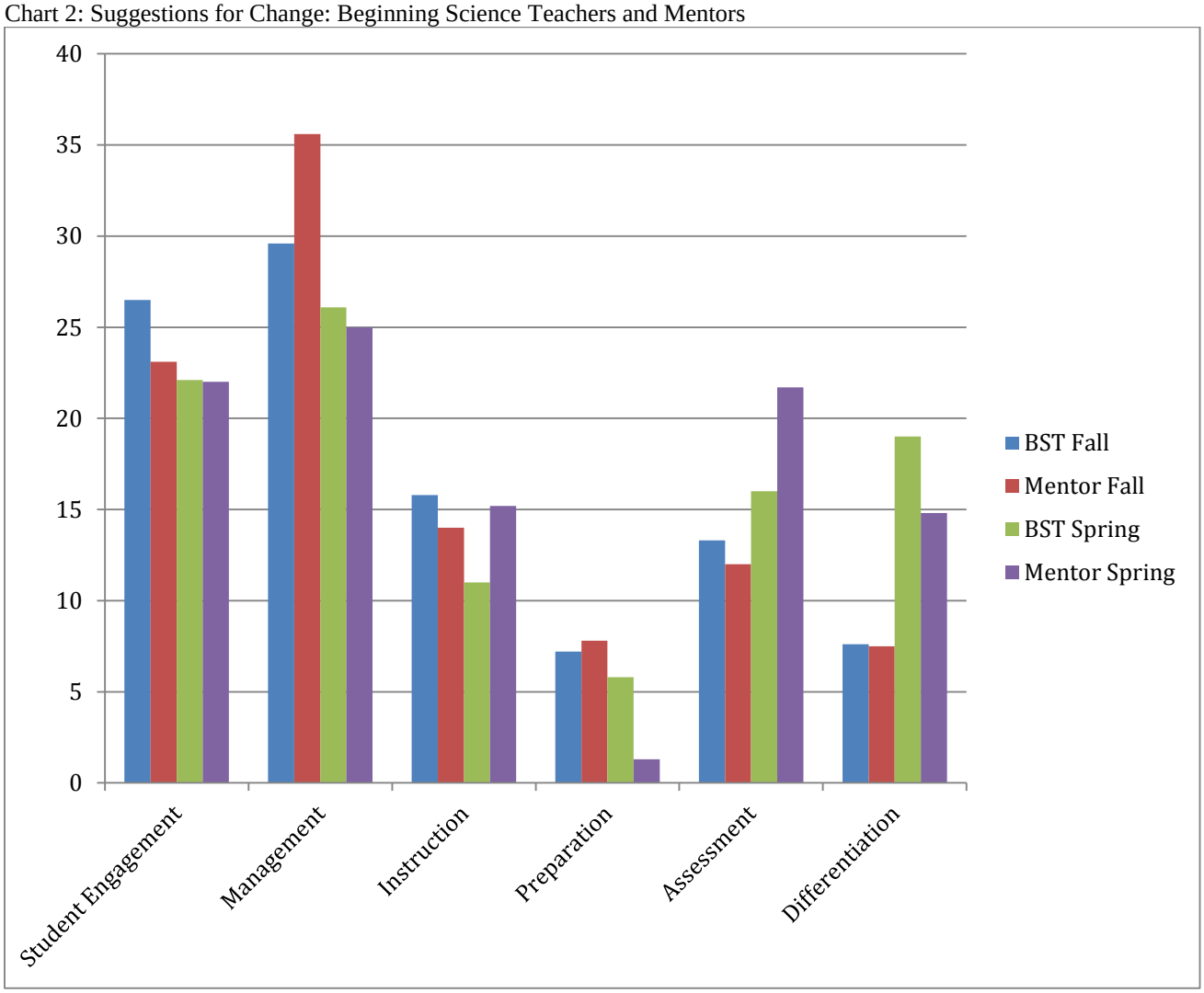
Appendix A

Chart 1: What About the Lessons Went Well: Beginning Science Teachers and Mentors



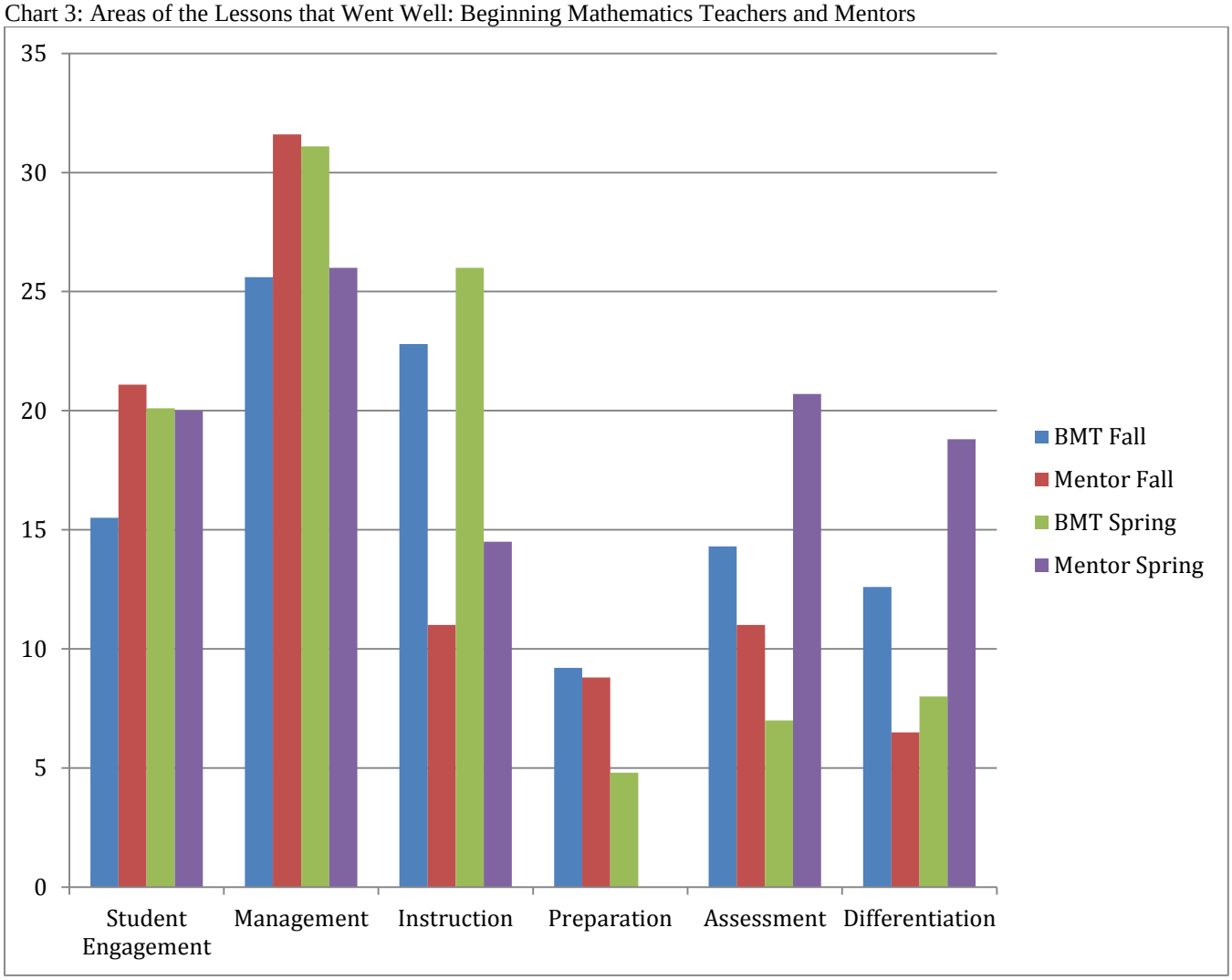
Appendix B

Chart 2: Suggestions for Change: Beginning Science Teachers and Mentors



Appendix C

Chart 3: Areas of the Lessons that Went Well: Beginning Mathematics Teachers and Mentors



Appendix D

Chart 4: Suggestions for Change: Beginning Mathematics Teachers and Mentors