A WEB OF INFLUENCE: HOW THE MSP PROGRAM HAS SHAPED THE THOUGHTS OF THREE INSTRUCTORS

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During the "What We Have Learned Symposium," the following question was posed to the members of the Content Course Fishbowl Discussion Panel: *How has teaching in this program influenced your own thinking about teaching and learning?*

Given this question, I immediately began to think about the instruction team for the Cohort II course, *Probability and Statistics*. This team consisted of three members: me, Sandra Overcash, and Nancy Wall. In preparing to teach the course, our first task was to revisit the course objectives and subsequently assign roles based on our expertise, interests, and interpersonal skills. It was especially nice to have three faculty members from different backgrounds, therefore not only adding three different perspectives, but also making the delineation of responsibility easier.

As the member with a terminal degree in our content area, it was often my responsibility to give credence to our claim that a deeper understanding of the K-8 content was critical for the participants' success as a Mathematics Specialist. I also tended to answer the more difficult content-related questions that arose, and strove to keep our delivered content cohesive throughout the summer. In contrast to my status as a relative novice to the Mathematics and Science Partnership (MSP) program, Nancy Wall has taught the class numerous times and has also served as a K-8 instructor for over twenty-five years. Hence, she brought a more intimate knowledge of what goes on inside the classroom, and reinforced our credibility with the K-8 teacher leaders with respect to the Virginia *Standards of Learning* and middle school curriculum. She was also assigned the task of leading most of the hands-on activities and helping us explore common mistakes and concerns with the curriculum. Sandra Overcash was a graduate of the MSP program and, along with Nancy, also served in the master teacher capacity. While she played a lesser role in delivering content, her primary task was to help us make the pedagogical connections within our MSP curriculum whenever possible. She led most, if not all, of the *Developing Mathematical Ideas* (*DMI*) module discussions; and, based on her own experience in

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the program, was able to keep us connected with the needs we were trying to address within our target audience [1].

The main point of the previous paragraph is to point out that, based on our personal experiences, strengths, and weaknesses, each of us brought something quite different, yet equally essential, to the program. Therefore, when answering the original question of what did we *take away* from the program, the question that seemed to naturally follow was, *"How did this 'take away' vary from one instructional team member to another?"* It is reasonable to think that our lessons learned and the extent to which we were each changed and influenced by teaching the course would also be shaped by our separate roles and personal experiences. With that in mind, what follows is each member's account of how the MSP teaching experience influenced their thinking about teaching and learning. I have written each of the following sections from the first-person perspective of the three aforementioned instructors based on a collection of interviews, informal discussions, and e-mails exchanged on the subject.

Sandra's Perspective: Serving a Community of Learners

As a graduate and subsequent instructional team member for *Probability and Statistics*, it may be fair to say that being an instructor in the program has influenced my effectiveness as a Mathematics Specialist just as much as participating in the program itself. In particular, the three areas in which I was impacted the most were: 1) my level of appreciation for the colleagues whom I coach; 2) my approach to accommodating diverse learning styles and mixed levels of preparation; and, 3) a better understanding of the value of cooperation.

Teaching the class has played a large part in shaping how I handle my responsibilities as a Mathematics Specialist. In thinking about the course *Probability and Statistics*, I clearly remember the extent to which we continually challenged the participants to grow in their ability to think deeply and challenged their preconceptions of how math should be taught. For some participants, this was a struggle; and, it was impressive to see them rise to the occasion as we seemingly made a habit of redefining what they thought of as "teaching best practices." With that in mind, when working with my own teachers during the school year, I have often thought about how much I am asking of them. Unlike the MSP participants, these are not teachers who are getting credit for a class or have an expectation of a new job title as a consequence of our interaction. Consequently, when I reflect on how difficult it was at times for us as the instructional team to stretch the minds of teachers who were *willing participants* in the learning experience, it serves as a constant reminder of the amount of patience I must continue to exhibit

as I serve in the capacity of a Mathematics Specialist. Such reflections also help to reaffirm the amount of gratitude I have for each teacher's willingness to work with me to build a better product for our students.

As for more tangible ways that the program has influenced my teaching and learning, I also remember how difficult it was at times to design and deliver a lesson that would meet the needs of each participant in the room *simultaneously*. From the kindergarten teacher to the eighth grade teacher, veteran to novice, K-2 certified to middle school certified, tactile to audio to visual learners; the backgrounds of our participants varied tremendously. While we expect such variation in regards to the students in our K-8 classrooms, I suspect that this may be overlooked by Mathematics Specialists when working with our colleagues. However, seeing how our instructional team rose to this particular challenge has given me better perspective on the needs of my teachers, and has shaped how I fulfill my role as a coach.

As an example, one activity that I fondly remember from *Probability and Statistics* is the lesson on tree diagrams. Jerome did such an outstanding job of taking what I thought would be a rather simple lesson and making it an activity that challenged everyone and caused them to question their understanding of the concept, as well as the strategies used to teach it. I primarily work with teachers on a one-on-one basis when coaching, but seeing the dynamics of the participant group and how they interact with each other reminded me of how diverse a given group of teachers can be in terms of their receptiveness, learning styles, and their ability to absorb new concepts. It also reminded me of how a well-crafted lesson can work to meet each (or at least most) of them where they are on the learning spectrum. As I am working in classrooms, I often keep the tree diagram activity in mind and use it as a reference point for how to construct my lessons. It serves as a reminder to always equip myself with ways to make an activity more challenging if needed, as well as being prepared to alternate ways to present the concept, whether for the entire class or individuals.

Along those lines, I am also reminded that in planning to teach *Probability and Statistics*, the task of figuring out how to sequence topics and activities in a manner that best suited short and long term retention, and being able to steer a group of adult learners without completely taking over was hard work! In watching the participants interact with each other and with the instructors, and knowing first-hand the amount of thought that went into each lesson's development, I am reminded of how critical it was to be respectful of the experiences of the participants while helping them to be reflective on their own knowledge and skills. This is a skill

that is tricky at best, but certainly one that I hold at the forefront of my mind as I continue to shape my own thoughts about teaching and learning.

Finally, the third reflection I have is on the co-teaching model. In our *Probability and Statistics* class and also the leadership class that I co-taught, there was a large investment of time and energy to plan for each class. Even though the class is pre-designed and has been taught previously, with every new cohort there is a need to think about the strengths and weaknesses of the specific group of participants *and instructors* for a particular course—and to revise and refine what we are doing accordingly. In the end, the stellar results made it clear that the co-teaching model is a valuable tool that is worth the investment, as it combines the strengths and unique perspectives of multiple instructors in order to deliver a product unique and custom tailored to the given audience. Despite previous experiences to the contrary, it became clear to me that the co-teaching model should go well beyond a simple delineation of duties. As a result, I have since sought to incorporate a similar strategy when coaching that will likewise draw on the advantages of a cooperative team.

Although I am a full-time Specialist, I do still teach classes of students on occasion. Fortunately, someone is always willing to share their classroom of students with me as I look to stay connected with the students while also figuring out the extent to which certain strategies and new ideas will work. Having such a worthwhile experience with the co-teaching model in the program has left me little choice but to ensure such co-teaching opportunities are well thought-out, well synchronized, and customized to the given subject, teacher, and audience. In doing so, my goal is to model for the students (and perhaps their teacher as well) the extent to which tacking a common agenda in a properly planned partnership can pay incredible dividends. This idea of enhanced synergy, together with the aforementioned notions of planning for diverse learners and furthering appreciation for teacher students, are clear evidence of the large extent to which the MSP program has impacted my approach to teaching and learning. For that, I am tremendously thankful.

Nancy's Perspective: Examples That Dig Deep

The textbooks are broken, and the exams don't help. In ten words or less, that is how I would summarize what I've learned from teaching in the MSP program. In the paragraphs that follow, I'll explain how I came to this opinion, as well as how it has changed my approach to teaching.

Although I've been in the classroom for over twenty-five years, it admittedly doesn't take long to realize that most students are susceptible to the same trap doors in mathematics. That is, after teaching any particular lesson multiple times, the errors that the students will make and the specific points that will consistently lead to confusion quickly become evident to the instructor. For instance, when middle school students learn about absolute value, many in the classroom will simply associate this operation with the notion of "reversing the sign." With that, I can usually guarantee that a handful of students will tell me that $|+3|$ must be -3. I typically presume that this tendency to jump to erroneous conclusions is a byproduct of a student's desire to find the "shortcut." We can often associate this mindset with students who ask questions such as, "will it always be this way?" Or, "I got the same answer by doing this, this, and that. Is that going to work every time?" In these cases, my guess was that these students were simply too anxious to establish a pattern in hopes of eliminating the need to understand on a deeper level. I assumed that such errors were solely a product of the student's approach to learning. However, teaching in the MSP program has shown me otherwise.

After working with MSP participants over multiple years and programs, I was surprised to find that the aforementioned pitfalls and traps for confusion (albeit different and at a higher level of content) were almost as predictable with the participants as with my middle school students. The difference, however, was that the participants were able to better communicate what they felt was the source of their confusion. Almost every time, it could be traced back to either the manner in which a particular concept was presented in their textbooks or the manner in which it was to be tested on a standardized exam.

In an effort to maintain the "Three C's of Instruction" (lessons that are clear, concise, and consistent) it seems that many textbooks and exams recycle the same examples to illustrate the concepts within. Unfortunately, while these Three C's may indeed be achieved, using the same textbooks, same examples, and same exam structures over multiple years has arguably led to a very narrow scope of understanding for students and teachers alike. Students and participants consequently seem to have trouble transferring examples to scenarios beyond what has been presented. This has only been exacerbated by standardized tests such as the Virginia *SOL*. With these tests in mind, we as teachers have often limited the scope of a topic even further, tightening the curriculum to the point where neither students nor teachers think outside of the proverbial box. Therefore, connections between topics, the ability to extrapolate concepts, and any sense of "a big picture" are lost. It has also led to a more microcosmic view of the material. For example,

we have suddenly become more concerned with how to label a graph rather than how to interpret it; perhaps, simply because the former is easier to assess on an exam.

Through countless conversations, "ah-ha moments," and the sharing of similar classroom experiences, the participants in the MSP program showed me that it is these confines that have created many of the traps and pitfalls mentioned earlier, and not necessarily a hurried approach to learning. To further illustrate the point, suppose that we were to put five teachers in a room, and ask each of them to provide three examples to be used to teach the conversion of pie charts to frequencies. My guess is that we may be surprised at how similar all five problem sets would be with respect to context, phrasing, and even the "nice numbers" used as denominators, etc. I base this guess on the fact that, for many of the topics that we covered, the points of confusion for the MSP participants seemed to be consistent across the class. The problem is that, as a group, by using the same tried and true examples to teach and learn the mathematics, we have set up confines for our thought processes without even realizing it. These confines have often limited how and when we think a given concept can be applied. This undoubtedly leads to the aforementioned false patterns, erroneous shortcuts, and misconceptions of the material presented.

The rich conversations that transpired in the MSP classrooms have caused me to ask more questions concerning the context *surrounding* the concepts that I teach. I now see how critical this can be when it comes to debunking erroneous associations and misconceptions within the mathematics. For example, in teaching graph types some important questions to ask are, do we (via our lessons, texts, or exams) limit ourselves to categorical data, or does the set of accessible examples extend to numerical data? Were we sure to show a scatter plot that *doesn't* show a trend, or did we only focus on the fact that trend lines can show positive or negative correlation? Did we discuss the calculation of median if there are more than 20 data points (because according to many books all experiments apparently stop at 10 or 20 observations)? For line graphs, do we always use years on the horizontal axis, or have we also included other measures of time? Again, while such questions may seem unsophisticated, it was eye opening for me to hear questions such as, "Don't the time units have to be seconds? All of the examples I've worked with show it in seconds, so I figured it had to be." While these comments may be troubling, it is a prime example of what we should expect when the scope of a given subject has been consistently funneled down to its simplest form.

In all, these considerations have reshaped how I teach my middle school students, as well as how I approach learning for myself. As I reflect on my MSP teaching experience, I am now

sure to take the students beyond the examples in the book. Rather than the blind application of exercises presented, I look for and often design examples specifically to debunk as many of the erroneous shortcuts as I can. I do everything in my power to ensure that the presented skill set is transferrable beyond the confines of the standard three examples used for a given topic. I look for patterns in the work presented and ask myself, when does this work, and when does it not? Being a part of the program and having the opportunity to work and share experiences with such wonderful teachers has reminded me that, whenever possible, I have to teach and likewise strive to learn for understanding beyond the scope of typical yet often mundane examples and exercises. If these perils of learning can affect the MSP program participants (who are some of the most talented teachers in the world), then they can certainly create havoc in the learning experience of a middle school student.

Jerome's Perspective: A Hands-on Experience

If there was one word that was added to my vocabulary as a result of working with the MSP program, it would be "manipulatives." While anyone with the slightest bit of experience in the field of Mathematics Education knows this term well, as a college professor with an engineering degree and no K-12 teaching experience, it was not a word that I heard outside of the occasional conference presentation on pedagogy. Simply put, most of us teach as we were taught, and not as we were taught to teach (if we were taught to teach at all); and, manipulatives were simply not a part of my personal learning experiences.

With only my traditional style of teaching to fall back on, I was more than happy to simply push content forward in the lecture format that most would expect in a college course, allowing for brief discussions when deemed appropriate, and the occasional break to work examples as a class. However, those sentiments began to change just a few days into teaching in the MSP program. In *Probability and Statistics*, every lesson was centered on an activity that involved a manipulative of some sort. While my buy-in was not immediate, I was fully sold by the end of the first course. The importance of hands-on activities as way to express and understand abstractions, as well as a tool to facilitate cooperative learning was suddenly obvious. In a presentation on virtual versus hands-on manipulatives, Hunt, Nash, and Nipper point out the advantages of manipulatives [2].

- The relationships formed (between concepts) by the use of manipulatives incorporate visual, tactile, and kinesthetic experiences.

- The use of manipulatives and activities add a component of "cooperative learning and reflective discussion [that] further enhances depth of understanding and the likelihood of retention [3].
- The authors quoted Moyer, et al. as stating, "Because it is advantageous for students to internalize their own representations of mathematics concepts, interacting with a dynamic tool during mathematics experiences may be much more powerful for internalizing those abstractions" [4].
- Promotes (learning and) teaching by more than just modeling a procedure on the chalkboard [5].

As the MSP program participants wrestled with new concepts and strove to mentally organize the content, I was fortunate enough to see all of the aforementioned components at work. With that, I not only embraced the concept of manipulatives and activity-based lessons, but quite possibly went overboard in my attempt to implement these aspects into my university curriculum. I returned to my classroom in the fall waving the flag of manipulatives, and seeking to implement hands-on activities into every lesson. It was not long before I hit a roadblock. The problem was that I was trying to add time-consuming activities to a pre-designed shared curriculum that *was not built* around such practices. Arguably, it was built to squeeze more than twenty weeks of material into a 15-week semester. In this system, pace was critical and lecture time was a priceless commodity. As a result, in trying to transform a curriculum overnight, I struggled with time management and completion of course objectives. It did not take long to realize that I had to come up with a different means to produce the same end. With little room to add to the curriculum, the ideal strategy would have to utilize components that were already embedded in the curriculum in order to achieve the desired outcome.

This quest for curriculum reform led to what I lightheartedly called the "rebirth of the high-numbered exercises." In most textbooks, these are the problems at the end of the section that are typically in paragraph form and involve "applied examples from fields such as business, pop culture, sports, life sciences and environmental studies that show the relevance of [the given topic] to daily life" [6]. Simply put, these are the exercises that we usually call "*word problems.*" Through discussions with colleagues and students, and after thinking about my own experiences, I realized that student disdain (and subsequent faculty frustration) for word problems has slowly phased out many teachers' willingness to tackle these more challenging problems at the end of the section. Yet these are in fact the exercises that (when well chosen and well presented) serve to: 1) bring the curriculum to life; 2) make the content relevant to topics outside of the

classroom; and, 3) promote discussion of the mathematics. These three attributes can serve to promote increased motivation for learning, improve long-term retention of content, and foster a cooperative learning environment. Thus, the hope was that an increased emphasis on these exercises would do well to mirror the previously mentioned advantages of manipulatives that I experienced, thus creating a replica of the MSP learning environment of which I was so fond.

However, to achieve these results, it was not enough just to reinforce the value of word problems. The order of the curriculum also had to be shuffled. I addressed this point at a recent Virginia algebra conference during a presentation entitled, "A Dramatic Approach to Real World Connections." The theme of our discussion was, "beginning with the end in mind" and during the presentation, we highlighted the use of role play and scenario building to motivate student learning and improve ability to connect topics within and across disciplines. The idea was to stop using the aforementioned word problems solely for assessment purposes. Instead, we proposed that these problems should be presented and discussed *before the lesson was taught.* In this manner, they could be used as a tool to achieve all three of the objectives enumerated in the previous paragraph. By presenting the students with a problem that on the surface seemed worth exploring, yet for which they lacked the tools to solve, interest in the upcoming section(s) increased tenfold, discussions abounded, and my classroom suddenly had the buzz of an MSP course. In addition, any negative effect on curriculum pacing was minimal as these were exercises that were already slotted to be covered (though often skipped) in the curriculum. However, given different placement and more emphasis, these exercises were transformed from being perceived as an unnecessary hurdle to jump at the end of each section to being the pinnacle of class discussions and motivation to continue learning.

Even beyond this particular strategy, what I have found was that teaching in the MSP program has invigorated my willingness to consistently evaluate my approach to teaching and strive for better results. As I sit in the back of my precalculus classroom, listening to my students engaged in a passionate discussion about Mount Everest, their unwillingness to climb it, and the need nonetheless to know how tall it is (a topic that is squarely based on an exercise in their textbook and will lead us directly into a lesson on the usefulness and application of inverse trigonometric functions) I listen intently and smile, appreciating that the MSP program has reminded me that teaching and learning can be so much fun.

A Web of Influence

For weeks, Nancy, Sandy and I worked together diligently to devise a course that would best serve the needs of the MSP program participants. Yet only in hindsight did we have any clue of the extent to which the relationship between instructors and participants would be symbiotic. Collectively, our three perspectives remind us of the extent to which the benefits of an MSP program are multifaceted. Though we usually focus on the success of our primary product (highly qualified Mathematics Specialists that will positively shape the lives of many) our personal experiences are a reminder that the depth and richness of the program continues to multiply even beyond our program participants as we (the instructors) also take these lessons learned back to our respective workplaces.

References

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