"Big Idea" Reflection Assignments for Learning and Valuing Mathematics

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Abstract

While participating in a Faculty Learning Community, we explored the "big questions" we wanted our students to take away from each of our mathematics courses. We called these questions the Big Ideas of the course, and we developed a Big Idea Reflection Assignment, which we continue to assign at the end of each of our courses. Students are able to demonstrate understanding and application of their learning as well as their values and appreciation of mathematics. The assignment encourages students to move beyond a focus on techniques and symbolic manipulations towards a broader and more holistic approach, including making connections between their learning and the Christian faith. We also noticed that the assignment changed the way we approach our teaching and designed our courses, so that our students are beginning to see our courses not as a collection of neatly packaged isolated chunks of material but as a unified collection of important mathematical ideas.

1 Introduction

The 2015 CUPM guide [12] suggests that

> Major programs in the mathematical sciences should present the beauty, fun, and power of mathematics. They should be designed so that all students come to see mathematics as an engaging field, rich in beauty, with powerful applications to other subjects and contemporary open questions.

Furthermore, many Christian faith-based institutions expect faculty to be engaged in integrating academic disciplines with faith commitments grounded in Christianity.

These are worthy but challenging goals. Students do not naturally associate beauty and fun with mathematics, and they have difficulty integrating all parts of life, particularly mathematics, within a Christian framework.

Mathematics instructors can fall into a trap of presenting mathematics in isolation without an overall or ultimate purpose. Most mathematics textbooks are written section by section where each section of material is neatly packaged into isolated chunks of material followed by several practice problems. While typical, the process does not always encourage us to connect the dots and present the course as a whole or relevant to Christianity. Such an approach encourages students to learn each section in isolation (and too often to quickly forget the concepts) without appreciating the context and without giving much thought to the overall themes of the course or purposes of their learning. According to Ken Bain's *What the Best College Teachers Do* [1], excellent teachers ask themselves what "big questions" a course will help students answer, and how we can motivate students to care about these questions. The best teachers stir up excitement and curiosity within students to explore the important issues and applications of the discipline. Bain's book stimulated our thinking about how we could focus our mathematics classes on the "big questions," which we called the "Big Ideas" of the course.

We (the two authors) participated in an interdisciplinary Faculty Learning Community [10] consisting of eight faculty members at our small, Christian liberal arts college in which the group developed the concept of Big Ideas and the Big Idea Reflection Assignment. The community was an outgrowth of a Teaching Squares program [4, 9] where four faculty members visit each other's classes with a group discussion at the end.

With support from our institution's Center for Teaching and Learning Excellence, our interdisciplinary community met biweekly for a year over lunch to discuss teaching and learning issues related to student reflection with the goal of developing an assignment that all participants could utilize in their courses regardless of discipline. The group was attracted to Bain's concept of "big questions" and how this concept could assess how students were engaging with their learning. How well were students learning the most important concepts of a course, which the group called the Big Ideas, and how well might they be able to remember and apply these ideas to their future studies, ministry, and personal life? Each member created a list of five to eight Big Ideas for a particular course. The accountability of the Faculty Learning Community then helped to refine the Big Ideas and to motivate their implementation [3].

What we found was that after we explicitly identified the Big Ideas of a course, we were more likely to communicate them to our students throughout the semester. We believe students better understood the purposes of the course, its design, and its assignments. The Big Idea Reflection Assignment turned out to be an effective teaching tool in itself because students were not only able to connect their learning to skills and concepts useful in the future, but the reflective process itself stimulated additional learning [13, 14].

2 Developing the Big Ideas of a Mathematics Course

Thinking about the Big Ideas for a course can be a challenging though stimulating process. Envisioning overall goals independent of "covering" specific content is exciting and freeing. If we believe mathematics courses ought to be required for all students because they help students to think or to appreciate the beauty of mathematics, how is that reflected in the structure of a culminating mathematics course? If we feel that the interaction of faith and mathematics is important, what evidence do we have that

students are making these connections? How will we know if students see mathematics as an engaging field, rich in beauty, with powerful applications to other subjects and contemporary open questions? We believe generating the Big Ideas for a course is a way to begin to answer these questions.

For example, we can "cover" the definition of probability in a Finite Math course, but we are free to help students discover the Big Idea of chance and surprising results. The content we need to cover may be important for a particular course, but the Big Ideas can provide purpose and meaning with various mathematical content. Calculus 2 could be viewed as the course after Calculus 1 and before Calculus 3 filled with integration techniques, sequences, and series. Alternatively, the purpose of Calculus 2 could be coming to terms with the infinite both in a mathematical and theological sense. Various mathematical topics may be used to meet the same Big Idea. For example, the Big Idea of seeing the beauty in mathematics could be taught with a unit on fractal geometry or a unit on number theory. While the lessons and teaching methods might be completely different, the Big Idea would be the same.

To begin generating the "big questions," Bain asks what it was that excited us about our discipline. What are the historical problems that motivated the creation of the course? For example, Real Analysis could be a course centered on developing mathematical thinking through the historical issues shaping the development of analysis with its various false starts of continuity and differentiability [6]. For one author of this paper (Case), the idea that the angle sum of a triangle need not be 180 degrees motivated him to pursue mathematics since "obvious" claims may not be so obvious.

Other questions to get started on developing our Big Ideas were: "What do we want our students to say when someone asks about what they had learned from our course?" and, "How do we want our students in five years to be able to apply what they learned in our course?" We wanted students to think about the most important concepts in the course, the interesting questions, and also how they could apply the concepts now and in the future. As Ken Bain describes it, "Learning takes place when [students] evaluate how they think and behave well beyond the classroom. [The best teachers] stress the need for students to grapple with important concepts and ideas . . . and have ample opportunity to apply their learning to meaningful problems" [1]. Parker Palmer states it this way, "Perhaps the classroom should be neither teacher-centered nor student-centered but subject-centered. Modeled on the community of truth, this is a classroom in which teacher and students alike are focused on a great thing, a classroom in which the best features of teacher- and student-centered education are merged and transcended by putting not teacher, not student, but subject at the center of our attention" [11]. Our goal then was to focus our courses on a handful of Big Ideas where we as teachers and students could join together in exploring the nature of mathematics and its meaning for our Christian lives.

Our previously developed course learning objectives in our syllabi were a place to start, but the course objectives tend to be more content focused and specific to current student outcomes, whereas the Big Ideas tend to be overall meta-goals that students can apply to the course as a whole with a desire for long-term understanding. One of the benefits of the learning community was sharing and defending our Big Ideas to others because we were reminded of our commitment to the discipline. In fact, we believe the Big Ideas are different for each instructor because they are dependent on what the instructor determines as the most important for the students to gain. We believe it is helpful for each instructor to think about what he/she thinks are the Big Ideas for each course and then communicate these to the students to help motivate them to learn.

The Big Ideas seem to work particularly well for liberal arts mathematics courses where a key goal is to help students understand the nature of mathematics and where the content is open to many different

preferences. (Appendix 1 gives a list of Big Ideas for a liberal arts mathematics course.) On the other hand, more content-dependent courses like Calculus and Geometry may also benefit from this approach because it forces one to identify the key ideas and confront larger issues such as how courses fit together within a major. It encourages the development of themes which transcend particular topics such as multiple representations which can benefit both pre-service teachers and those going to graduate school. (Appendix 2 gives examples of Big Ideas from courses for mathematics majors.) When the instructor articulates the Big Ideas, topics can be woven together to present an important and useful branch of mathematics.

3 Developing the Big Ideas Reflection Assignment

After developing our list of the Big Ideas for a course, the next step was to determine how to word our reflective assignment for students to complete. Instead of evaluating the class experience, we wanted the students to reflect on what they had learned in the course and give them an opportunity to communicate that learning. We explicitly told the students to focus on their own learning. The assignment is not a course evaluation since there are other instruments to evaluate the course and the instructor. For the reflection assignment, we listed all the Big Ideas of the course (usually five to eight), and we asked students to choose three of these Big Ideas that they thought they had met through the course. Giving students the choice of the three allowed for more ownership of their work. For the three they chose, they were to write a short reflection (about half a page each) explaining how the course experiences had helped them accomplish the Big Idea. For each of the three reflections we asked them to include three components: 1) describe what activities in the class helped them learn this Big Idea, 2) analyze how this Big Idea helped them think more like a mathematician, and 3) apply this Big Idea to their future career, service, ministry, family, etc. (See Appendix 1 for the complete assignment.)

While there was flexibility in how we as instructors implemented the Big Idea Reflection Assignment, we generally had students complete the reflection assignment toward the end of the semester and gave students credit as part of their homework score. The assignment was a good way to review the main concepts at the end of the course and give students an opportunity to recognize the intention and experiences of assignments to integrate the course concepts. By asking students to connect the course content to their lives, we believe they had a greater sense of engagement with the material. By asking students to give personal examples of how they were learning, we believe the reflection stimulated higher-order thinking and solidified their learning. Metacognition is difficult to measure, but our readings of their responses indicate an awareness and understanding in their thought processes throughout the semester in a way an exam could not do.

Since we knew students would be completing the reflection assignment at the end of the semester, it also encouraged us as instructors to talk about the Big Ideas throughout the semester. The assignment motivated us to discuss with students *why* we were assigning projects, reflective papers, group activities, etc., because these activities were designed to help students learn the Big Ideas. In this way the course seemed to fit together because there was a reason for everything we did. In fact, we feel like this has changed the way we teach. Instead of teaching various topics and skills, we now focus on teaching the course as an integrated whole contributing to the broader educational mission of the institution.

4 Analyzing the Results of our Big Idea Reflection Assignment

We were pleased when we evaluated the results of our students' responses to the Big Idea Reflection Assignment. In addition to the three main components of the assignment, our students demonstrated a higher level of metacognition than we had expected with evidence of deep thinking about what they had learned instead of just restating their original knowledge. The reflection helped us understand how students were thinking in their conception of Christianity and Mathematics. Somewhat surprising to us was how students expressed evidence of learning on the affective level as they discussed motivation for learning the ideas and excitement over discovering new concepts. A fellow professor in our faculty learning community crystallized what we observed, "[The Big Ideas assignment] gave affective feedback on the class – not just what they had objectively learned (I had other measuring devices for this). I was able to see where students were inspired and discouraged, and what they felt like they didn't really understand" [3].

4.1 Skills and Concepts Attained

In responding to the first prompt, students described the skills and concepts related to the Big Ideas that they believed they had attained through the course. A calculus student mentioned development in her problem-solving and communication skills:

> I'm confident that I will be able to think more creatively when it comes to problem solving. Overall, accomplishing this big idea will increase my ability to see new perspectives and make connections among different topics. ... In this class my communication skills were sharpened ... I now understand that different people learn different ways ... Now, if one doesn't understand something right away, I don't just give up and say, "Ask someone else," rather I explain it with a new approach.

Several students mentioned that they developed and learned to value skills in the area of working cooperatively, a skill that they will be able to apply to their future studies and careers. One student said:

> The [group projects] were often a challenge as I tend to like to work alone . ... I found that while working in groups I was able to gain completely new perspectives on problems that I never would have been able to come up with. I found myself over and over again being extremely surprised when a team member would come up with a brilliant solution to a problem that had never even crossed my mind. Through these experiences I have gained a value for other people's ideas that I never had before. This will help me in the future as I will have to work with others and understand that other people may have equally good if not better ideas than me and I will need to be humble and let others help me when I am stuck on a problem and need a fresh perspective.

Reading what key skills and concepts the students believed they were learning encouraged us particularly when they reported being hesitant of a Big Idea at the beginning of the semester and buying into it by the end of the semester.

4.2 Thinking Like a Mathematician

Parker Palmer [11] suggests that "we honor both the discipline and our students by teaching them how to think like historians or biologists or literary critics [or mathematicians] rather than merely how to lip-sync the conclusions others have reached." While a traditional, content-oriented exam may help in measuring how a student thinks and reasons, it has difficulty assessing how a student conceptualizes the nature of mathematics. The Big Idea reflection assignment asks how students have learned to think more like a mathematician as a result of exploring the Big Ideas in a course.

Students expressed a sense of gaining a new way of "seeing" as a mathematician. One student commented, "The ideas of calculus are incredibly useful and, once you know them, you start to see them everywhere. Knowing things such as derivatives and integrals gives one a new perspective and approach to problems, an approach far closer to one that a mathematician would use." Another student commented, "I had never thought of mathematics being beautiful. I had always thought of it as being very analytical and precise–with no room for creativity or beauty. But through this course, I have been shown many ways in which math can be beautiful.... In the future, I think I will be more aware of the beauty around me, and maybe even find beauty in something that others may not see." Another student agreed, "Beauty and mathematics go hand in hand, and I did not see it until this class."

Many students seemed to enjoy looking at mathematics in terms of the Big Ideas. "Prior to this course I honestly was somewhat bitter towards math and had a lot of negative experiences.... Now I see math as a way to have fun; though not in all respects necessarily. I can enjoy sitting and drawing a tessellation or playing with shapes." One suggested that "being able to find enjoyment in math was hard, just because none of my teachers have ever really helped me and given me the opportunity to try it for myself. So given this opportunity I took it and now can reap the benefits of it. This can help me in finding joy in all areas of my life, no matter the consequences or circumstances." Others reported new ways of thinking. "Concepts that stretch one's thinking were a constant in [the liberal arts math course]. The 4th dimensional thinking stretched my thoughts. I had to consider a reality that was beyond my normal view of the world. This is humbling as well as interesting."

Finally, students began to see precise thinking as something important that they were learning in mathematics. In an introduction to proofs course, a student commented:

> I have developed many frameworks that will help me think more like a mathematician. Relating this question back to the big idea, I am now more likely to be skeptical about what is true and not true. Rather than taking information and assuming it is right because someone told me so, I am more likely to dive into why the statement is right, or find a way to alter the statement. I also am more likely to be more careful in the way I present my proofs and to make sure what I am saying is actually true.

Another commented, "The big take away that will be applicable for the rest of my life is that there is typically more than one way to solve every problem we encounter in life." The Big Idea Reflection Assignment allowed students to articulate how they could think more like a mathematician and see mathematics all around them.

4.3 Application to Future Life

The Big Idea reflection asks students how they could apply what they had learned in their math course to their future studies, ministry, and personal life. Several students wrote how they enjoyed seeing the connections between mathematics and other subject areas and others focused on the thinking process itself. One calculus student commented:

> Now when I encounter problems in the real world I will be able to approach things with the logic and reason that this class has taught me. In my future career, family, or whatever I will be able to utilize these skills.. . . Whether it's in the finance world, engineering, chemistry, or numerous other areas, the problem solving learned in Calculus is vital and the actual tools that it gives you are very powerful.

One student said, "This Big Idea (learn to solve problems and experience real-world applications of mathematics) has taught me that I should not limit what I learn to what I think will be immediately relatable. By sticking with and engaging Calculus, I was able to find beauty in math and I was able to apply it to my life." This comment encouraged the instructor because it demonstrated that the students were not just learning mathematics content, but through that content they were applying the Big Ideas to their lives.

4.4 Issues of Faith

As Christian instructors at faith-based institutions, we hope we are able to integrate mathematical concepts with our Christian faith, but it is difficult to know how well our students are making those connections in our mathematics courses. We were encouraged by comments like this:

> Another topic that I have connected with through this class is dealing with issues of faith. I have seen God all throughout this course. From the Fibonacci Numbers in nature, to infinity, to the fourth dimension . . . Finding ways to relate my faith to mathematics has helped me relate my faith to other aspects of my life. I want to acknowledge the Lord in everything I do.

Another student in a liberal arts math class said:

> One of the hardest parts of math for me in the past was not being able to see any real application. . . . This class, however, helped me greater understand its importance, primarily by relating it to my spiritual life. . . . Now I can see math in the world around me in a more real way . . . and how it beautifully ties into God and His magnificence.

Calculus students often connected the study of the infinite with God's nature. One commented that "as we looked at series, sequences, and all the other things involving the concept of infinite it was interesting to realize that we will never fully understand the infinite and I now see a deep connection between the infinite attributes of God." Another said:

> I don't know what the future holds for me — one of the limitations of being finite, myself, I suppose. However, this area of math provides a reasonable allegory for the person of God: while humans (and mathematicians alike) can never grasp the width and breadth of God, we certainly benefit when we allow the Infinite into our problems (both mathematical and spiritual).

Students in an introduction to proofs course made connections between the assumptions in mathematics and the assumptions in our faith. One wrote, "Going forward, I will try to be more careful to avoid allowing my (unsubstantiated) assumptions to give me false security in knowledge. Analogously, I ought to be careful in assuming knowledge about God and biblical doctrine. We often refer to God as 'infinite.' What does that even mean?" Another student wrote:

> Similarly, my doctrine is naturally influenced by assumptions. These assumptions could come from my cultural and familial context, era in history, personality, and/or influence of the flesh. This does not disqualify my beliefs as invalid or wrong (genetic fallacy). It simply means that I ought to have high standards for absolute truths.

The Big Idea Reflection Assignment gave students an opportunity to reflect and write about the connections of mathematics and their faith while providing us instructors a glimpse into their conceptions of faith integration.

Longtime ACMS member Gene Chase [8] breaks down three areas of integration:

1. Incarnational Approach: Who am I?
2. Incompleteness Approach: What do I not know?
3. Imago Dei: What do I know?

It appears from our student reflections that most students incorporate all three areas to some extent, but most comments regarding mathematics and Christianity fall into the second category. A calculus student remarked, "Going forward, I will try to be more careful to avoid allowing my (unsubstantiated) assumptions to give me false security in knowledge" and "my doctrine is naturally influenced by assumptions. These assumptions could come from my cultural and familial context, era in history, personality, and/or influence of the flesh." Also, "I don't know what the future holds for me—one of the limitations of being finite, myself, I suppose." Gene Chase notes that the incompleteness approach is not as complete of a perspective as what we would like because it has a "God of the gaps" feel to it. On the other hand, a positive of the Incompleteness Approach is that it captures a sense of humility, awe, and mystery before a great God. In our examination of the reflections, the mathematical areas in which this awe is elicited generally involve interesting patterns, infinity and the higher dimensions.

5 Benefits of the Big Ideas

The written feedback from students solidified our expectations that they really were "getting" the Big Ideas. Before this assignment, we hoped they were learning the main ideas in the course, but after reading the student reflections, we were much more confident they were meeting the course expectations.

The responses revealed a higher level of metacognition than we had expected, and rather than resistance, most students seemed to welcome the opportunity to discuss the course's impact. Brookfield [7] suggests in three core assumptions regarding teaching: "that skillful teaching boils down to whatever helps students learn, that the best teachers adopt a critically reflective stance towards their practice, and that the most important knowledge we need to do good work is an awareness of how students are experiencing their learning and perceiving our teaching." While the assignment is inappropriate for summative assessment, the student reflections provided a rich source of assessment for us as teachers about how students believed they were learning in our courses. The reflections assisted us in discerning which assignments were effective for learning, how our students were applying the concepts, how they felt about their learning, and which Big Ideas seemed to be working, particularly those related to faith integration.

Somewhat surprisingly, we realized we were more intentional about teaching the Big Ideas because we knew that the students would be writing about what they had learned at the end of the course. The Big Ideas reminded us to regularly steer the students toward the important questions and applications of the course, sometimes writing a key question on the board before class started. We designed class activities that day to help students begin to explore the answer to this important question.

As instructors, we found that developing the Big Ideas was very energizing, as it released us from the constraints of the content that had to be covered and helped us remember why we enjoyed teaching and learning mathematics in the first place. The Big Ideas essentially changed the way we teach by forcing us to view our courses as a whole and by encouraging us to design assignments and activities that highlight the most important aspects of the course.

6 Conclusion

We found the Big Idea Reflection Assignment was a very valuable teaching tool that helped our students describe what they had learned and how they could apply that learning in the future. Students seemed to enjoy writing about what they were learning in their mathematics classes. One student said, "I will admit, I was fairly skeptical about written reflections and group projects in a math class, however, they have been pleasantly enjoyable." She goes on to discuss why they were helpful for her, "I really enjoyed writing reflections, they gave me space to explore concepts and how they apply to my current life and who I want to be in Christ in the future. Being able to write about math has helped to expand my writing skills and thus my written communication ability. Being able to write about things that seem like they are hard to describe will be a great advantage in the future." Because of the success we have seen from our students, we have now integrated the Big Idea Reflection Assignment into all of our mathematics courses, and we (and our other Faculty Learning Community members) have enjoyed opportunities to share our results with other teachers. We have appreciated the journey of developing the Big Ideas approach, and we now have more enthusiasm for our teaching.

We believe our students are benefiting from mathematics courses that are unified by important questions and themes, and we enjoy reading about what they have learned from the Big Ideas each semester. One student said the assignment was great review for the final because it "helped me to see the educational value of this course and tie everything back together." While writing assignments may be utilized in mathematics courses for various purposes [5], we have found that one of the best uses is to allow students the opportunity to reflect on what they have learned throughout a course. Through writing, students are able to put together the major themes of the course, the instructor's purposes, and various assignments,

and they are able to value course applications. As mathematics teachers, this "group project" has taught us what it is like for our students when we make a group assignment. We are learning the joys and challenges of investigating and doing mathematics cooperatively, which is one of the Big Ideas in our mathematics courses. Our hope is that our students are beginning to see our courses not as a collection of neatly packaged isolated chunks of material but as a unified collection of important mathematical ideas.

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Appendix 1: An example of a Big Idea Reflection Assignment

MAT 120 Investigations in Mathematics
Reflection Assignment # 8

Choose three of the following "Big Ideas" of MAT 120 that you believe you have particularly met through this course. For each of the three "Big Ideas" you choose, write a short reflection explaining how the course experiences have helped you accomplish this "Big Idea." (Each of the three reflections should be about half a page each, for a total of at least 400 words.)

For each of your three reflections, answer the following:

1. What were some valuable course activities, assignments, projects, discussions, or topics (probability, finance, numbers, geometry, etc.) that helped you grasp this component of the course? (**Describe**–the past)
2. In what ways have you developed skills that help you "think more like a mathematician" when you now encounter problems? (**Analyze**–the present)
3. What are some ways that you can apply this component to your future studies, ministry, and personal life? (**Apply**–the future)

BIG IDEAs of the Investigations in Mathematics Course:

Big Idea #1 Begin to appreciation the Beauty and nature of Mathematics.

Big Idea #2 Issues of Faith–Explore life lessons and issues of faith, including ways to be good stewards of our resources and how to use math to make wise decisions.

Big Idea #3 Group Work–Actively investigate and do mathematics individually and cooperatively.

Big Idea #4 Investigate–Problem-Solving strategies and Critical Thinking skills (particularly using Diagrams and Similar/Simpler problems) to solve problems.

Big Idea #5 Develop and Stretch your mind and explore the consequences of Surprising ideas while being inquisitive and open-minded.

Big Idea #6 Enjoy your experience in a Fun and challenging classroom environment that develops a sense of friendly community.

Big Idea #7 Apply–experience real-world applications of mathematics that you can apply to issues in your everyday Life.

Appendix 2: Additional examples of Big Ideas for various courses

Calculus 2

Big Idea #1 Multiple Representations -using various perspectives such as symbolic, numerical, graphical, and verbal techniques to solve problems.

Big Idea #2 Slice, Approximate, Sum, Evaluate–Slicing up functions or graphs so that the varying amount is nearly constant on the subinterval and then integrating to find volumes, areas, work, etc. Extending elementary fixed ideas (rate x time) to varying quantities.

Big Idea #3 Undoing differentiation to draw conclusions from graphs and to integrate functions using w-substitution, integration by parts, partial fractions, etc.

Big Idea #4 Recognizing that finite sensibilities do not always work when dealing with the infinite such as sequences, series, domination, LHôpital's rule, and Geometric series.

Big Idea #5 Developing critical thinking skills in identifying assumptions in problem solving and translating verbal statements into mathematical statements in order to model real world situations.

Big Idea #6 Developing workforce skills in using technology, working with others to solve difficult problems and to resolve individual differences, and writing technical reports.

Big Idea #7 Developing study and learning skills to tackle difficult concepts and to reflect on one's learning.

Big Idea #8 Create your own. Be sure to articulate the big idea.

College Geometry

Big Idea #1 Experience the axiomatic development of a mathematical subject and recognize the importance of methodology, logic, and models.

Big Idea #2 Develop skills in critical thinking, deductive thinking, writing, writing proofs, recognizing flaws in arguments, and advanced mathematical reasoning.

Big Idea #3 Stretch your mind by exploring the consequences beyond the "certainty of mathematics" or beyond what appears to be self-evident or common sense thinking.

Big Idea #4 Recognize the tremendous impact non-Euclidean geometry had on the nature of mathematics.

Big Idea #5 Develop and critique teaching strategies for high school geometry.

Big Idea #6 Investigate the role of the visual and the deductive statements in solving problems and believing the validity of the results.

Big Idea #7 Hear the suspense story of the discovery of non-Euclidean geometry through the role of the parallel postulate

Big Idea #8 Determine another big idea of the course.

Modeling with Numerical Analysis

Big Idea #1 The computer is fallible–Understanding error as it inevitably occurs in order to detect, predict, and minimize error as well as identifying the shortcomings of numerical recipes.

Big Idea #2 Skeptically examining solutions–Examining assumptions, using sensitivity analysis, and other means to determine how much the answer and computer output should be trusted.

Big Idea #3 "It depends"–Understanding other criteria such as cost and speed in getting a "good enough" answer, and questioning whether a "right answer" is even feasible in solving problems.

Big Idea #4 Reality? Really?–Using various and sometimes indistinct criteria in developing and critiquing models of their inherent shortcomings which accompany trying to mirror reality. (And to what extent).

Big Idea #5 Why we do not know everything–The nature of scientific computing (adding more points is not always the answer, human solutions are not always as good as computer solutions, the rule of diminishing returns in using more terms) which limit our understanding and which areas of current research would greatly enhance our understanding if progress were made.

Big Idea #6 Our Series–Using the fundamental theoretical tools such as Taylor series to approach numerical problems and why these are often not the best way but they are important first steps.

Big Idea #7 Your own big idea. Define and describe another big idea of the course.