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Article

Practical Applications of an Integrally Christian Approach to Teaching Mathematics

Valorie Zonnefeld

Descriptions of various frameworks and approaches to integrating Christian faith in the mathematics classroom are explored, as well as examples and techniques. In particular, a subject-centered approach is advocated in contrast to the traditional teacher-centered approach or, more recently, the student-centered approach.

Teaching Christianly has been a passion of mine since I first felt the call to teach. Unfortunately, connections to the spiritual realm are less overt in mathematics than in other disciplines. Throughout my teaching at the middle school, high school, and now collegiate level, I have wrestled with finding a distinctively Christian approach to teaching mathematics. When I first began teaching, I knew in the back of my mind that what I taught was no different from that at secular institutions. Math concepts do not change from school to school. The fact that a triangle has 180 degrees is the same in the secular and the religious school. I comforted myself that the math was the same, but the atmosphere that I created made my classroom distinctive. I became increasingly uncomfortable with this response, with nagging thoughts that there must be more to a Christian approach to teaching mathematics than this.

I have been given opportunities to work with both pre-service and practicing teachers to explore their thoughts regarding the integration of faith and mathematics. In both settings I have asked, "What does Christian mathematics teaching look like?" Pre-service and practicing teachers alike readily offered their insights into the topic. Responses have included patience, creating a community of learning, caring for students, acknowledging each student's individuality, kindness, and honesty. I immediately followed this question by asking which of the responses represented distinctively Christian teaching and which represented qualities of any good teacher. It soon became apparent that many of the qualities that were valued as *distinctively Christian* also described good teaching in general.

Christian educators do not hold a monopoly on good teaching, as many unbelieving teachers also display strong teaching qualities through common grace. While it is true that a Christ-like attitude and the fruit of the spirit (love, joy, peace, patience, kindness, goodness, faithfulness, gentleness, and self-control) are character traits that Christian educators should display, I have come to believe that this view limits the possibilities for integration. Math is not neutral. As a Christian educator, I have realized that there are more opportunities to integrate faith in mathematics than I once believed. Harold Heie, retired senior fellow at the Center for Christian Studies at Gordon College, has aptly stated that if God is the Creator of all that is true, there ought to be connections between our faith and mathematics.[1]

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Distinctively Christian mathematics teaching goes beyond the teacher's treatment of the students and the classroom environment. In this response, I will outline the journey that I have taken regarding my approach to having faith integral to mathematics teaching: the purpose of teaching mathematics from a Christian perspective, frameworks that have been used to describe approaches to faith integration, and effective teaching techniques that I have found for integrating faith and mathematics.

When I started teaching classes at a Christian college, I was forced to reexamine my belief that my classroom environment and treatment of students fulfilled my obligation to teach from a Christian perspective. I thoroughly enjoyed teaching the classes, but one disappointment was the students' responses to the last question of the course evaluation: "*How has your faith or biblical perspective been shaped or deepened by this course or your instructor?"* Answers included blanks, "N/A," "It's a math course," "Not really, but it's math, so that's fine," and "Not really, it's just math." I was heartbroken that few students acknowledged any deepened understanding or even that I had made an effort in my teaching to acknowledge the Lordship of Christ in mathematics. My love for the Lord made no apparent impact on my class or students. I was "deepening the world's hunger rather than helping to alleviate it" in my teaching of mathematics.[2] This experience pushed me to search for a more faithful way to teach mathematics from a Christian perspective, and it led me to David Smith.

The Purpose of Teaching Math

Like Russell Howell,[3] Smith has also been a resource for me in considering the integration of faith and mathematics. I had the opportunity to hear Smith speak twice in 2008; he played an important part in deepening my understanding, inspiring me to view my curriculum planning and teaching in a new light.[4] The question that he repeatedly asked was, "What would spiritual development look like if it showed up in your salad?" He pushed me to examine what spiritual development would look like in my classroom. This question forced me to reevaluate the goals for my classroom. Smith prompted me to dream about my ideal Christian mathematics classroom: a classroom community of learners striving to learn more about the mysteries, beauty, and usefulness that God has interwoven in the spatial and physical dimensions of reality, an environment which prompts students to ask, "Lord, what would you have me do for you with this knowledge?"

The purpose of learning mathematics plays an important role in creating a distinctively Christian approach to teaching mathematics. David Huizenga writes, "The purposes of mathematics can clearly distinguish the Christian school classroom from its secular counterpart," in that secular academics can hold knowledge as a tool to manipulate and control for individual gain.[5] The implicit goal of mathematics in this environment is all too often to "get ahead" and "make lots of money." This misguided purpose for mathematics lies in opposition to the goal of Christian education and many of the mission statements of Christian institutions.

Christian educators must renounce this abuse of mathematics and boldly reclaim mathematics education for Christ. Abraham Kuyper stated, "There is not a square inch of creation of which Christ does not say 'It is mine!'"[6] This includes the square inch represented by mathematics education. Richard Russell uses the understanding of the sovereignty of our Lord over creation to describe the responsibility of Christian educators: "Our task as ambassadors of the Kingdom in the field of education is to reclaim every area of educational thought, learning and practice" for Christ.[7] This reclamation process causes educators to examine all aspects of educating, from assessment to discourse and curriculum. Given the enormity of this task, how does a teacher begin this reclamation process?

A solid understanding of the *purpose* of teaching mathematics is an important foundation for Christian teachers. Parker Palmer describes education as guiding students "on an inner journey toward more truthful ways of seeing and being in the world."[8] When the above is applied to mathematics, students will see the purpose of mathematics not as an avenue for personal gain, but as a tool to carry out their God-given calling.[9] Mathematics is "a tool for redemption" and directs students "toward the Creator rather than toward the created."[10] This distinction between the Creator and created has been a helpful tool for me in identifying educational purposes that have gone wayward.

The "aha" moments when the class is amazed at the mathematical beauty that God has built into the placement of leaves on a tree or the use of hexagons in honeycombs are wonderful, but practically speaking, not every lesson inspires students to a greater appreciation for God. In fact, I have often experienced the opposite, as my students have expressed disgust for algebra or integrals. This is the time when it is vitally important that teachers understand the purpose of mathematics and the importance of an understanding of the numerical and spatial aspects of creation as we exercise our dominion over creation. This also makes it imperative that Christian teachers be able to answer the "When will we ever have to use this" question. At times, the answer to this question may be that we can learn more about creation and our Creator, but students also need to see the practical applications of the mathematics that they are learning. Some students do not readily see the beauty in mathematics, but they may be drawn to its incredible utility.

The purpose that a teacher holds for mathematics may also be communicated implicitly through the topics selected to illustrate mathematical concepts. Are the problems all about maximizing profit and minimizing expense in a materialistic sense, or do they examine problems from contexts such as decreasing pollution, stewardship of resources, or understanding the spread of a deadly virus? A steady flow of problems solely focused on personal gain sends an unspoken message to students that mathematics is not a tool for redemption, but for personal advancement.

As has been argued, the purpose that a teacher holds for teaching mathematics is revealed through subtle differences that provide overtones throughout a class. Next, we examine various frameworks for education that Christian educators have used to integrate faith and mathematics.

Frameworks

Multiple approaches to addressing faith and mathematics are used by Christian educators. This section will start with an examination of the term "integration," followed by James Nickel's three approaches to integration.[11] The section closes with Smith's spectra of integration.[12]

Integration or Integral?

I have used the term *integration* of faith and mathematics knowing that it may lead to a misunderstanding. To integrate implies connecting two things that are separate parts like combining peanut butter and chocolate for a recipe.[13] Mathematics and faith are intimately connected and need not be integrated. More appropriately stated, faith is integral to mathematics. To follow the food analogy, mathematics without faith is the equivalent of skim milk: the faith (or fat) has been removed. As Howell has so aptly argued in his essay, faith and mathematics are intimately interwoven.[14] Unfortunately, educators have sought to teach mathematical concepts in isolation, losing their connections to reality and, consequently, to faith issues. Despite my misgivings with the word integration, it is the most commonly used word for Christian educators. For these reasons, I will continue to use it with the caveat that I see integration as rejoining things that were originally joined and meant to be seen as unified aspects of reality.

Approaches to Integration

In *Mathematics: Is God Silent?,* Nickel describes three approaches that Christian educators have used to integrate their faith and mathematics.[15] The first is mathematics as usual. A dualism is present in this approach in which the Bible is sacred, but mathematics is secular. An educator who uses this approach would expect no difference between the mathematics classrooms of a believer or an unbeliever, since mathematics is secular. A Christian school that adopts this philosophy hangs its faith integration on activities such as chapel, morning devotions, and Bible class while leaving the subjects themselves untouched. Howell makes a beautiful argument against this separation in both the lead article in this issue and the book *Mathematics through the Eyes of Faith* that he coedited with James Bradley.[16] Mathematics is not secular, but clearly displays the beauty and structure of our Creator.

The second approach that Nickel describes is "baptizing mathematics." In this approach, spirituality is sprinkled on mathematics without really affecting the subject or the class. Examples of baptizing mathematics include tacking a scripture onto a lesson or offering a prayer before class with little connection to the subject or activities. One of the Christian mathematics curricula currently available looks no different

than traditional curricula, with the exception of the Bible verse on the top of each worksheet—a verse largely unconnected to the topic of the lesson. While baptizing is an easy approach to implement, it also displays dualism since the actual mathematics and the spiritual act are disconnected.

This second approach has also aptly been described as the *frosting approach* with mathematics providing the cake and faith, the frosting over it. Similar to a cake and frosting, the cake inside (mathematics) remains unaffected by the frosting (spirituality). Huizenga states that faith integration must go "beyond a devotional or an opening prayer, [to] search for and unveil Christ in every concept, every formula, every proof, [and] every operation."[17]

The final approach outlined by Nickel uses the all-encompassing integration described by Huizenga, recognizing God as the foundation of all knowledge. In this approach, everything visible and invisible reflects God. In studying mathematics, we learn more about the nature of our God. In this third approach,

> teachers of mathematics … bring to the attention of their students the power and beauty of mathematics. [Letting] the students not only know what math can do, but [also letting] them admire it for its elegance and order, and [giving] glory to God for what he has revealed to man through it.[18]

What a beautiful picture of an approach to mathematics that is integrally spiritual. It is this final comprehensive approach that I desire for my classroom, but find challenging to accomplish. If faith is integral to mathematics, it moves beyond a Bible verse at the start of a lesson to affect not only the purpose for learning math and the types of problems chosen, but also the classroom dynamic. In the next section, we will explore comprehensive integration that is coherent, grounded, and authentic.

Integration Spectra

Smith has offered three helpful spectra to consider when examining curricula that integrate faith and learning.[19] Each spectrum offers a continuum of one descriptor versus the second with a goal of reaching the second descriptor. These spectra have helped me reflect on my own classes' faith integration. The first spectrum is *fragmented* versus *coherent*. In a fragmented curriculum, the scripture does not change the heart. Including a spiritual reference or verse allows the teacher to check off faith integration and move along with mathematics class as usual. This is in contrast to the integral use of biblical concepts to enlighten the learning. An example of coherent faith integration is examining the ratio of doctors to people in different areas of the United States and the world. Issues of justice and caring for downcast members of society are powerfully demonstrated while still learning valuable knowledge about ratios.

The second spectrum is *spiritualized* versus *grounded*. In the spiritualized approach, faith issues are introduced, but quickly drift away from mathematics with no real connection. A spiritualized approach finds a weak connection between mathematics and faith, and shifts from learning about math to a spiritual discussion. An example of a spiritualized approach might occur when teaching the quadratic formula. A teacher introducing the discriminant would follow with a sermonette on how Christians, too, should be discriminating. The connection between the quadratic equation and wise choices is tenuous at best. Issues including justice, stewardship, the spread of diseases, and human behaviors offer depth and vital connections between faith and mathematics that are both spiritual, yet grounded in mathematics and students' daily lives. Hilgeman states, "Integration must always be meaningful, or students will develop a lack of respect for God's truth."[20] Students need to see practical, grounded applications of faith in mathematics.

The third spectrum is *decorative* versus *authentic*. In a decorative approach, the Bible is stripped of its authority as it is brought in, but never really used. An example of the decorative approach is exploring applications of geometry using instructions for building the temple in 1 Kings. Similar to Nickel's description of baptism, the Bible is used, but spiritual matters do not really change anything.[21] Authentic integration of faith and learning may still use 1 Kings in a geometry lesson, but would not stop short of authentic integration. Closing questions could bring the integration from decorative to authentic; for example, what is God communicating through these passages? how does God view worship? and does this change how you view your church building? Authentic integration affects the heart as students and teacher alike are stirred by the power of the scripture.

At this point, you may be thinking that designing a classroom and curriculum where faith is integral to mathematics is difficult. While it is difficult, everybody can take small steps to more faithfully unfold mathematics in their classrooms. The next section will describe examples of practical techniques to integrate faith and mathematics.

Integration Techniques

Teacher-Centered

A false dichotomy has been built in recent decades pitting teacher-centered approaches against student-centered approaches. Teacher-centered approaches have traditionally been the norm in mathematics classrooms. This approach is characterized as *teaching by telling*. The educator disseminates knowledge of procedures while the students absorb it.

> It assumes that the teacher has all the knowledge and the students have little or none, that the teacher must give and the students must take, that the teacher sets all the standards and the students must measure up.[22]

This approach has received increased criticism from educators and educational researchers who believe that students learn mathematics by doing math. Thus, the only person learning in a teacher-centered classroom is the teacher.[23] As a result, a growing number of mathematics educators have pushed for student-centered approaches.

Student-Centered

Student-centered approaches move away from the *sage on the stage* model in teacher-centered approaches to place the teacher as more of a *guide on the side*. I spent the better part of a decade moving my classroom from a teacher-centered to a student-centered approach, believing that it was a better method of teaching students. I worked to incorporate pedagogies that allowed students to scaffold their learning by constructing knowledge and assimilating it to prior knowledge. I assimilated many constructivist pedagogies including incorporating jigsaw techniques, fostering student discourse, and crafting guiding questions. All of these techniques allowed students to be more deeply involved in their learning. I believed that compared to the traditional, teacher-centered classroom, a student-centered classroom was a better and more respectful approach to working with students as image bearers of God. Students are not minds to be filled, but unique persons who learn in multiple ways. I focused on meeting students' needs emotionally, physically, and developmentally so they could be actively involved and engaged in their learning.

While I have not abandoned involving students in their learning, I became increasingly uncomfortable with the philosophical underpinnings of student-centered approaches. My fear was, and remains, that educational theorists including John Dewey, Maria Montessori, and Ernst von Glasersfeld go too far with constructivism and student-centered learning by allowing students to construct their own knowledge. Dewey sees students not as constructing ideas from their environment, but as "observers, participants, and agents who actively generate and transform the patterns through which they construct the realities that fit them."[24] Taken to an extreme, student-centered approaches allow a student to decide that $2 + 2 = 5$. This is a dangerous step toward social constructivism in which the bedrock beliefs of Christianity become irrelevant as students construct their own realities. This is inconsistent with Christian beliefs of absolute truth.

Another difficulty that I faced with a student-centered approach was how it fed the individualism present in our society. Christians value individuals as each is created in God's image. Unfortunately, Western culture has distorted and elevated the value of the individual resulting in students, and eventually adults, who are self-serving and self-promoting. Ideas of community and working for the benefit of all, take a back seat when individuals believe that they are number one.

Subject-Centered

It is against these misgivings that I read Palmer and later Maryellen Weimer who promote a fresh approach to pedagogy.[25] Weimer criticized the false dichotomy that juxtaposes teacher-centered and student-centered approaches as pitting teaching versus learning; she states, "The best teaching is not one or the other, but a combination of both."[26] Palmer concurs with this, suggesting a subject-centered classroom.[27] This was a breath of fresh air to me, since I was not comfortable with either the student- or teacher-centered approaches.

Since that time, I have worked to adjust the focus of my classroom from students to the subject, seeking to lead my students to uncover the truth God has placed in mathematics. God's truth takes center stage. Similar to the student-centered approach, I remain the "guide on the side" and still plan learning experiences that encourage my students to be actively involved in their learning. One of the advantages of guiding students is that when students discover a concept on their own, they internalize it and learn it at a deeper level with greater retention.

In a subject-centered classroom, both the students and the teacher are actively involved, but it is the subject that takes center stage. Curiosity along with cognitive dissonance are harnessed to draw students in to learn more about topics in mathematics. For example, a lesson on odd and even numbers may be motivated by the question, "can you think of any four odd numbers that add up to 19?"[28] Students will explore possible combinations of numbers and make guesses until they realize that pairs of odd numbers always have even sums. Similarly, pairs of even numbers also have even sums. In this example, it is curiosity about mathematics that propels the subject to the center of learning, giving students "direct access to the energy of learning and of life."[29] I believe that a subject-centered approach is a more faithful way of unfolding the beauty and mystery that God has created in mathematics with students. Through a focus on the created (mathematics), students learn more about the Creator (God). A subject-centered approach avoids the overemphasis on either teachers or students and focuses on the truths of the concepts that often challenge students and teachers to a deeper understanding.

Teacher and Student Roles

The roles of both teachers and students are important in a subject-centered approach and take time to establish. Teachers are responsible for orchestrating opportunities for students to immerse themselves in the subject and for guiding students as they wrestle for greater understanding. A weakness of some student-centered approaches is that they can emphasize students so much that they reduce the authority and knowledge of the educator in the room. The teacher holds a unique role as an expert who can point students in the right direction and guide them to resources and materials to further their learning.

The "lawful regularity of creation" is particularly pronounced in mathematics.[30] This makes mathematics especially suitable for a subject-centered approach as the subject itself, through its regularity, guides students unlike other subjects in which conclusions may be more ambiguous. The regularity of mathematical rules and conclusions, along with the importance of students internalizing mathematics, is why I believe that teaching mathematics is unique: helping students less, often results in more learning. If teachers say too much, they diminish the learning opportunity and decrease the cognitive demand. It is through cognitive dissonance that students seek to organize their learning and pursue answers to their questions. This is the reason why an important aspect of high quality mathematics teaching is diagnosing students' level of understanding and guiding them to the point where they can make connections to the learning at hand.

In a sense, diagnosing and guiding is similar to playing the game Catch Phrase® in which the clue giver (teacher) guides their team (the class) to say the secret word without actually saying the word themselves. As the team guesses, the clue giver continues to improve the clues given in response, pointing them closer to the secret word and guiding them away from distractors. On some level, mathematics educators play this game on a daily basis in a subject-centered approach, guiding students toward understanding without saying too much and diminishing learning opportunities. By setting the subject at the center, the teacher's job is to connect the student to opportunities and resources for learning about the subject, that is, learning about an aspect of the creation.

The imagery of a team playing a game and working together for a common outcome is an apt description of my ideal classroom. I want the students in my classroom to collaborate with both the teacher and other classmates as they work together to enhance each member's learning. This collaboration is a reflection of what God desires for his body as individuals work together to learn more about the intricacies he has woven throughout mathematics.

A subject-centered classroom is more comfortable for both teachers and students. In a teacher-centered classroom, the teacher is a performer. This increases the expectation of a flawless performance.

For teachers in this setting, "getting caught in a contradiction feels like a failure."[31] In a subject-centered classroom, students understand that the teacher is an expert, but is also still learning alongside the students about the vast intricacies that God has concealed throughout mathematics for humans to uncover. In this setting, a mistake does not signify a failure, but rather an opportunity for learning. In classes where I have most successfully designed a supportive, subject-centered atmosphere, students take my missteps as opportunities that challenge them not only to learn more about mathematics, but also to help push forward the learning for the community. Palmer describes it well:

> In a subject-centered classroom, gathered around a great thing, getting caught in contradiction can signify success: now I know that the great thing has such a vivid presence among us that any student who pays attention to it can check and correct me … students have direct, unmediated access to the subject, and they can use their knowledge to challenge my claims.[32]

It is likely in a subject-centered approach that unexpected turns will more frequently reveal areas that are unknown to the educator, including mistakes. In a collaborative classroom community, teacher mistakes no longer represent weaknesses, but an opportunity for teachers to model not only the Christian virtue of humility, but the fact that they, too, are life-long learners.

The traditional, teacher-centered approach, in which educators present already-worked, error-free material, leaves many students with the incorrect notion that those who understand mathematics never make mistakes. Unfortunately, this facade of perfection causes many students to believe that they are not part of the mathematics community because they frequently make mistakes as they master new concepts. Mistakes are a natural part of mathematics, and educators need to model that they, too, make mistakes and do not have answers to every question. This humility and honesty that can be so lacking in mathematics classrooms is strikingly similar to the humility and honesty necessary as we progress in our own faith journeys.

An additional advantage of a subject-centered approach is that it does not force students to enter the teacher's domain in a teacher-centered approach or similarly force teachers to enter the students' territory in a student-centered approach. Both students and teachers maintain their identity and unique roles, as they gather around the subject as learners.

A subject-centered classroom is also an easier setting in which to practice the Christian virtue of hospitality. In a subject-centered classroom, the community of learners can be more comfortable for students since the instructor is no longer seen as the possessor of all knowledge and evaluator of the student. Granted, assessment will need to occur at some point, but a relationship of working together with the teacher as guide to uncover mathematical knowledge is more inviting to students who hold anxiety toward the subject. The teacher no longer grants access to mathematics since mathematics is the center of all work. Recent technological advancements support a subject-centered approach as students now have more methods to access mathematics than was traditionally available with only the teacher and textbook. This environment, in which all are seeking to deepen their knowledge of mathematics and in which competition is not emphasized, is a more hospitable environment for students to learn about math and its Creator.

Conceptual Teaching

Closely connected to a subject-centered approach is the importance of conceptual teaching: teaching in which students learn not only *how* a concept works, but also *why*. The saying "an ounce of understanding is worth a ton of memorization" supports this.[33] A conceptual approach is in conflict with the current push for high-stakes testing which pressures educators to cover every area of their field, often at the expense of a deeper, more conceptual understanding. The result is shallow knowledge of many topics that, unfortunately, does not last. Palmer suggests that instead of telling students everything they need to know, "information they will neither retain nor know how to use," teachers need to bring students into the circle of practitioners.[34] In other words, students need to be introduced to how mathematicians think and relate in a community of truth. Palmer states that in doing this "we do not abandon the ethic that drives us to cover the field—we honor it more deeply."[35]

Huizenga agrees with this approach, stating that shallow learning gives students only the human descriptors of God's truth in mathematics.

> When we insist (by the very way that we structure lessons and assignments) that students attain and display a measure of real understanding of mathematical relationships, we bring them into contact with divine truth and beauty.[36]

This face-to-face meeting with God's divine truth in mathematics is what I desire for my mathematics classroom.

A Caveat

A subject-centered approach does not imply that lectures are eliminated and every class period will consist of circle time around a mathematical topic. Weimer emphasizes the importance of recognizing "when 'teaching by telling' effectively advances the learning agenda."[37] The difference between a teacher-centered and a subject-centered class is that a lecture is selected when it is the most effective means of learning more about the subject.

A subject-centered approach chooses from both teacher-centered and student-centered approaches, including "lectures, lab exercises, fieldwork, service learning, electronic media, and many other pedagogies, [both] traditional and experimental" to find the best pedagogy to learn more about the topic.[38]

The recent push for student-centered classrooms has given lecture a bad rap; some of this criticism is warranted given the over-dependence mathematics education has had on lecture. Yet, the baby should not be thrown out with the bath water as there is a time and a place for lecture. Though beyond the scope of this article, there are also methods that make lecturing more effective and engaging to students. What is important is that the teacher orchestrate learning experiences that most effectively allow the subject to be the center of the class, those pedagogies that most faithfully allow the truth of mathematics to be seen by students. If teaching by telling is the most effective method for that topic, then a well-designed and implemented lecture is the natural response. The key to choosing a technique is that "at the center … is a subject that continually calls [students and teachers] deeper into its secret, a subject that refuses to be reduced."[39]

Questioning

Another technique that I have found fertile for integrating faith and mathematics is the use of essential questions and significant questions.

Essential Questions

Essential questions are overarching questions that guide the course or unit. Each course that I teach includes essential questions that not only give a big picture of the objectives, but also integrate perspectival connections. Examples of course-wide, essential questions that include a spiritual connection are, where does math come from? is math created or discovered? what does God reveal to us in math? what role do we have as image bearers of God in math? how are Christians to use math? and what does God communicate through mathematics? Unit-based, essential questions are more focused, but still give a macroview of the concepts and skills; for example, how can algebra describe creational phenomena? what laws of probability has God built into creation? and how can I use statistics to honor or dishonor my Creator?

Starting with essential questions grounds the course or unit in its place in God's creation. Unfortunately, many students see mathematics as a set of hard-to-reach, abstract rules or tricks, with little meaning in their daily lives. The framework of essential questions allows me to reflect on an elegant solution or beautiful pattern as more than a coincidence; it is also an opportunity to learn about the beauty and organization that God has built into mathematics. The essential questions are also a method to remind students that when we learn about mathematics, we learn more about the Creator and his creation.

Significant Questions

A second questioning technique that is useful for integrating faith and learning is significant questions. This technique also stems from Smith's work.[40] Howell mentioned Smith's work briefly in his coverage of attitudinal issues.[41] I would like to examine Smith's emphasis on a curriculum that gives opportunities for spiritual growth in greater depth.

Smith gives an example of squirrels and trees to demonstrate a curriculum that is fertile for faith integration. Squirrels climb trees. Trees were not

explicitly made for squirrels and squirrels were not explicitly made for trees. However, God made trees with rough bark, and he made squirrels with claws to climb. As a result, squirrels are constantly climbing trees. If the trees were smooth or slippery, the squirrels would not climb them. The trees allow affordances for squirrels to climb. Likewise, as mathematics educators, we can design our curricula to allow affordances for spiritual and moral growth.

As a foreign language educator, Smith worked to recontextualize his teaching so that it allowed affordances for spiritual growth. He still taught the same concepts as the textbook, but in a different context, one fertile for faith integration.

Recontextualizing mathematics is an interesting and motivating way to teach. Too often, schools present a fragmented reality. Aspects of creation are distilled in 45-minute allotments with little connection from one course to the next. Not only are courses disjointed, but also mathematics itself is often disconnected from reality. Hilgeman warns, "Students who learn principles without their application to life will never consider math important."[42] Recontextualizing mathematics offers applications of mathematics as well as possible opportunities for perspectival issues and faith integration.

Examples of Integration

The remainder of this article will give examples of significant questions and recontextualizing mathematics. A majority of my teaching experience is with secondary mathematics and entry-level undergraduate courses. While the reader may teach more-advanced classes, I believe that these examples will stimulate others to imagine applications for their specific courses.

Personal Finance

My first attempt at recontextualizing mathematics was a unit I developed on personal finance for high school students that raised issues of poverty and justice.[43] As my first attempt at significant questions, this unit took a fair amount of time to develop. After this experience, I found it more natural to introduce questions into my lesson plans, and I was surprised at how frequently significant questions naturally arose throughout classes without previous preparation.

Converting Rates

An unexpected significant question occurred as I taught my students how to convert rates. Previously, I had demonstrated several examples using the typical questions of inches per year, miles per gallon, and so forth. On this particular day, I asked the class to estimate the number of seconds per life the average student will spend in church. Students were impressed by the large number and responded with surprise about the length of time they spent in church. If I had stopped here, I would have simply baptized the concept with religious language. Their response, however, provided a perfect lead-in to questions such as the following: what if we calculated the number of seconds playing basketball or listening to music? and would an examination of your calendar make it clear what is important in your life?

The context of time allowed the students to learn not only about rates, but also about how time reflects our priorities. One class, in response to the rate calculations for time in church, recognized that worshiping God occurs in other ways and places that were not accounted for, such as personal devotions and activities done to God's glory, including activities such as planting flowers and even sitting in math class. The beauty of a significant question is that it has the potential to evoke a heart response in students. Using this approach to teaching rates took a few extra minutes; however, I found that students learned the material at a deeper level. Compared to the previous years that I had taught rate conversions, students understood rates at a more profound, conceptual level because they were engaged with a recontextualized use of mathematics that was relevant to their lives. More importantly, this new approach to teaching rates allowed affordances for spiritual growth.

History

Math history can be a useful vehicle to integrate faith and mathematics. For example, the slow development of probability theory and its roots in gambling help students understand how humans took a beautiful aspect of creation and distorted it for financial gain. Similarly, when teaching the Pythagorean theorem, students love to hear about the Pythagoreans' strange practices and their worship of numbers. It is an ideal time to share how the Pythagoreans distorted reality by worshiping the created (numbers) instead of the Creator (God). Students are shocked

to hear the extreme measures the Pythagoreans took to protect their worship of numbers. It provides the teachable moment to ask if there is something that is out of balance in students' lives. Are they worshiping the created instead of the Creator? Including the history of mathematics gives a context to mathematics. It helps students understand humanity's role in uncovering the elegance and order that God has designed within creation.

Ratios and Proportions

To teach ratios, I have students measure various parts of their bodies including sections of their fingers, the height and width of their head, their wingspan, and height. Students are surprised to find that the ratios of each student's body parts are so similar. I then introduce students to phi and the golden ratio describing how humans value objects that display the golden ratio as beautiful, including the many features present in their own bodies. Students are then amazed to see the many applications of the golden ratio and the golden spiral that God has embedded throughout nature.

Action figures and Barbies® are also a great resource for teaching proportions. Students are asked to measure various body parts of their figure. These measurements are then converted using proportions and the height of the average male or female to find what the dimensions of a life-size action figure or Barbie® would be. This activity not only gives students a realistic problem to practice proportions with, but it also brings up perspectival issues. Students understand that the image of action heroes and Barbies® presents a vision of strength and beauty that is physically unattainable. This is an ideal opportunity for educators to reemphasize the importance of a positive body image and the beauty that God has given to each student.

Types of Numbers

Although a simple example, I have found teaching about domains often brings up opportunities for the definition of human life. Typical questions include the best type of number to use to describe each situation. I include an example that results in an answer of 15.7 people. When I ask, "Is 15.7 a good domain for describing people?" I leave plenty of wait time for student responses. Without fail, one student will sometimes jokingly, or seriously, ask if 15.7 is accurate to describe a group that includes a person who is missing a body part or limb. I redirect this question back to the class, and they conclude that a person missing a body part is still a person. As Christians, we believe that it is the soul that constitutes personhood. Although a small example, this domain problem reemphasizes the importance of each human being, regardless of their physical state.

Conclusion

These are just a few suggestions for faith integration. The possibilities are limited only by your imagination. As Galileo noted, "God wrote the universe in the language of mathematics."[44] From the patterns of seashells to pinecones and the ocean waves, God has covered creation with his mathematical fingerprint. The number of ways to teach lessons and demonstrate mathematics is infinite. This points to another aspect of God that we can learn from mathematics, that he is infinite as well.

It is exhilarating to show students how God has imprinted his personality, beauty, creativity, and orderliness in the area of mathematics. I long for a classroom and curriculum that acknowledges that God is sovereign over *all* creation. I want a curriculum that causes students to delight in the concepts being studied and in which students and faculty are seen as image bearers who work in concert to build a learning community in which Christ's sovereignty is acknowledged throughout. Students are asked to answer the question "How can I use mathematical knowledge to help redeem every inch of creation for the glory of God?" That is the same question that I have struggled to answer throughout this article and throughout my journey to teach more integrally. "How can I use my mathematics classroom to help redeem every inch of creation for the glory of God?" *Soli Deo Gloria!* ◈

Notes

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[34]Palmer, *The Courage to Teach*, 122.
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[36]Huizenga, "Integrating Faith and Math," 21.
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