Writing Math Lessons That Integrate Christian Beliefs: The Kuyers Institute Grant Project

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Introduction

As Christians and mathematics teachers, we face the daily challenge of making connections between our discipline of mathematics and our Christian faith. We bear the responsibility to uncover and expose some of these connections for our students. This paper describes a project designed to produce a series of individual math lessons and week-long math teaching units that provide opportunities for teachers and students to learn mathematics in the context of underlying Christian beliefs and principles.

Historical Background: The Charis Project

The current project traces its inspiration to similar work completed in the late 1990s in Great Britain. Prior to 1980, the national curriculum in Great Britain required schools to train students in a variety of areas, including moral and spiritual development. In practice, however, matters relating to religious faith were relegated to topics in theology and philosophy courses. One would not expect to find any explicit references to faith or religion in other courses such as literature, science, and mathematics.

Under the conservative governments of Prime Minister Thatcher, however, a seemingly innocuous change was made to the legislation relating to the national curriculum that has had far-reaching effects in all disciplines, including mathematics. Parliament approved an amendment that moved the requirement of moral and spiritual development to the preamble of this legislation. Legally, this change had the effect of requiring all disciplines to document ways in which moral and spiritual development were taught in the classroom. Thus, matters of faith and religion moved from the restricted realm of theology and philosophy classes to the entire school curriculum, including mathematics, and at all grade levels. Furthermore, the Office for Standards in Education was created in 1992 and charged with making regular inspections of local schools to ensure that the goals of this amended legislation were achieved.

In this context, the Charis Project was created and given the mandate to develop school materials that integrated moral and spiritual teachings with every discipline. Initially, working groups developed lessons in the areas of English, French, German, Science, and Mathematics. Materials produced by this organization are available at minimal cost and with liberal reproduction and dissemination policies (for more information contact The Stapleford Centre at charis@stapleford-centre.org).

As of 1997, the Charis Project team had created nearly 20 individual lessons for ages 14-16+, essentially a high school level. Several lessons for the middle school level have also been developed. As our project team analyzed these lessons, a few conclusions were

reached. First, the lessons tend to follow one of three basic approaches. One approach is to study math concepts in a context that brings moral or spiritual issues into the classroom discussion. For example, a lesson on statistical concepts such as measures of central tendency and visual displays of data is situated in the issue of providing economic aid to countries around the world through a relief agency called Oxfam. Students construct graphs and compute averages but also engage in issues such as the global distribution of wealth and the link between infant mortality and life expectancy. A second approach uses math as a metaphor for a deeper spiritual concept. One such lesson focuses on logical reasoning but is entitled "Moment of Truth." A third general category is the use of math as a means of worshipping the God of Creation. A lesson such as "Can You Draw It?" fits this description and encourages students to respond with awe and wonder at the abilities that each person possesses.

The Kuyers Institute Grant Project

In 2004, Jim Bradley learned about the Charis Project from David Smith, one of the members of the project who had recently joined the faculty at Calvin and was appointed as the director of a newly created agency called the Kuyers Institute. This institute supports the work of research teams as they seek to find ways to integrate faith and learning. David described the work of the Charis Project, and Jim thought that a similar project would prove useful in schools both in North America and around the world. Jim also reflected on a recent in-service workshop at a local high school where he discussed themes from his co-edited book "Mathematics in a Postmodern Age: A Christian Perspective." The response from several Christian teachers was a plea for advice on how to teach individual math concepts and lessons from a Christian perspective.

Jim wrote the grant application and assembled a team consisting of high school math teachers (Eve Ricketts teaches at Grand Rapids Christian High School in Michigan and Andrew Busch teaches at Fremont High School in Michigan), an education professor (Jan Gormas works in the graduate program in curriculum and instruction at Calvin College and completed doctoral work in math education), and three mathematics professors (Gary Talsma specializes in math education in the math department at Calvin College, Dave Klanderman specializes in math education in the math department at Trinity Christian College, and Jim Bradley has interests in a range of areas of mathematics and computer science in the math department at Calvin College). The funded grant calls for this team to develop a series of individual math lessons or short math teaching units with completed lessons to be ready for classroom testing during the 2005-2006 academic year.

During the initial team meeting, we noticed that most of the math lessons developed by the Charis Project focused on math concepts in the areas of statistics and data analysis. Since many high schools in North America emphasize the areas of number operations, algebra, and geometry (cf. NCTM Standards, 2000), we used an initial brainstorming session to identify a variety of potential topics in the areas of algebra and geometry. At the same time, we generated a list of two dozen or more spiritual and moral issues that might provide a fruitful setting for one of these math lessons.

Our team established a few additional groundrules for our work. First, we hope that our lessons will prove useful for teachers in a variety of settings (public and private) in a variety of locations (North America and worldwide). For this reason, we have already selected a wide array of pilot schools to test our lessons during the upcoming school year and would welcome additional suggestions. Second, we decided to organize the moral and spiritual topics under four principal themes: the nature of God, the beauty, order, and regularity of God's Creation, the effects of the Fall of mankind into sin, and the Redemption of the world and its people through the death and resurrection of Jesus Christ. Third, we sought to develop lessons at either the middle school or high school level, including a significant number of lessons in algebra and geometry to complement other lessons in areas such as data analysis. Finally, we plan to make the completed products available for free, through both downloadable files on a project website and freely-distributed CD-ROMs or flash drives.

The list of topics currently under development include:

1. Mathematics and the Nature of God
2. A two-part study of Mathematics and History
3. Patterns in Creation (including the Fibonacci sequence and the golden ratio)
4. Exponential Growth (including bacteria, world population, investments, etc.)
5. Hypercubes (a study of higher dimensions using mathematical analogy)
6. The Gender Gap (a focus on the algebraic and graphical meaning of regression)
7. The Challenger Explosion (a study of the interpretation and use of data)
8. The Indian Tsunami –December 2004 (trigonometric and logarithmic functions)
9. Paper or Plastic – No Thanks (polynomial and other functions and curve fitting)

Several other lessons are also under development at this time. The next section provides a brief overview for two of the lessons listed above.

Hypercubes

Gary Talsma has developed a multi-day unit on the geometry and related algebraic patterns of n-dimensional cubes. He has used earlier drafts of these lessons with accelerated middle students attending a weeklong summer math camp, but this unit would also work well with high school students and even undergraduate students enrolled in a liberal arts math course or in a content course for elementary and middle school preservice teachers. The spiritual dimension of this lesson centers on people created in God's image (cf. Genesis 1:26-27) and given the ability to imagine things that extend beyond the physical senses. In turn, this lesson encourages students to detect and explore patterns that God has built into creation. As such, this lesson fits the "Creation" theme mentioned earlier.

The series of activities allows teachers and students to reason by way of mathematical analogy and pattern extension to describe the attributes of both familiar objects (a point, a segment, a square, a cube) and unfamiliar objects (a hypercube, a 5-dimensional cube, and an n-dimensional cube). The primary math content areas are geometry and algebra in the context of combinatorics. Students use provided sketches and draw their own

diagrams to help analyze cubes in higher dimensions. The final activity provides an opportunity for students to use algebraic patterns and combinatoric reasoning to complete a table of attributes, in terms of lower dimensional cubes, for a cube of each dimension. It is expected that this series of connected lessons would be useful in both algebra and geometry classes. Teachers may choose to use some of the initial activities and perhaps reserve later activities for a future course or for enrichment.

The Gender Gap

Andrew Busch designed this lesson to be used in his own public high school mathematics classroom. Due to this fact, the moral and spiritual theme is less obvious, especially in the student materials. The link is briefly stated at the outset of the lesson, namely, the students will become more aware of issues related to social justice and gender equity. It is assumed that teachers will return to this overall discussion in the context of analyzing the data and at the conclusion of the unit.

The three-day unit is based upon census data for the past 50 years that provide median salaries for all male and female workers in the United States. This data is used to produce two linear regression equations and associated correlation coefficients. Students are then asked a series of questions to interpret the graphical results of this regression analysis and to apply the linear equations to make predictions of future median incomes for males and females. This lesson is primarily connected to data analysis and statistics with some attention given to linear functions in the tabular, symbolic, and graphical representational modes.

This lesson highlights several important pitfalls in the application and interpretation of statistical tests. First, it should be noted the income data for the past half-century tend to follow an exponential model more than a linear model. Given the exponential nature of both inflation and income growth, this result is not surprising. At the same time, statistics are frequently misapplied, and the narrowing of the data range to 1970-2000 makes the graph appear to be quite linear. Second, we must be careful about using regression equations to extrapolate beyond the domain of the data. Later questions in the activity ask students to predict when (or if) the female median salary will surpass the male median salary. A response to this question requires a person to extend the lines of best fit many decades beyond the actual data range. Furthermore, seemingly contradictory evidence from a ratio of female to male median income can be later explained by once again noting the that the underlying relationship is not linear, but more likely periodic in character. Students completing this series of lessons will gain an appreciation for both the usefulness and the limitations of mathematical models.

Upcoming Events and Future Challenges

The project team will meet in August 2005 to review the final draft of the lessons earlier mentioned along with any additional lessons that have been completed. The next phase of the project is the piloting of some or all of these lessons at a variety of schools around Michigan, around the United States, and around the world. Following the 2005-2006

academic year classroom testing of the lessons, the project team will meet in the summer of 2006 to make final revisions and to initiate the distribution of the completed products.

As we continue developing these lessons, a few challenges remain. Since these lessons will be used in both Christian and public schools, the team is still debating the extent and the location of the spiritual and moral aspects of the lesson. To allow for the greatest degree of flexibility in use, we will likely place most of the content related to Christian beliefs in the teacher notes and resources. In terms of pedagogy, we currently have a variety of locations for this spiritual and moral dimension of the lesson, ranging from an overview at the beginning, comments interspersed throughout, and a summary either midway or at the end of the teaching unit. In addition, Jim Bradley will complete the final editing process and will need to achieve a harmony of pedagogical styles in the lessons developed by the different members of the project team. It is the hope and expectation of the entire team that the final result will be a package of lessons that are well-written, connected to our Christian beliefs, devoted to sound mathematical concepts, and able to be used by many different teachers in many different school settings. We encourage any reader desiring more information to contact a member of the project team.

References

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