Chapter 15

Supporting Pattern Exploration and Algebraic Reasoning through the Use of Spreadsheets

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ABSTRACT

As teachers prepare to teach the Common Core State Standards for Mathematics (CCSSM), students’ exploration of patterns and relationships between numbers has gained more importance. Specifically, students’ conceptual understanding of numerical patterns is critical in middle school, as it lays a groundwork for fostering mathematical thinking at all levels. Educational technologies can enhance student’s explorations of patterns by providing opportunities to represent patterns, test conjectures, and make generalizations. In this chapter, the authors illustrate how spreadsheets can support students’ explorations of both arithmetic and geometric patterns in the middle grades.

INTRODUCTION

According to Mason (1996), “at the heart of teaching mathematics is the awakening of pupil sensitivity to the nature of mathematical generalisation” (p. 65). We consider identifying and describing patterns, whether numerical, geometric or algebraic, as a foundation for mathematical generalizations. School mathematics standards throughout the world (e.g., National Curriculum Board, 2009; National Council of Teachers of Mathematics, 2000; National Governor’s Association/Chief Council State School Officers, 2011; Qualifications and Curriculum Authority, 2007; Singapore Ministry of Education, 2007) require students to recognize, generate, and understand a

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variety of patterns that are not immediately apparent. These include linear and nonlinear patterns that can be represented numerically, graphically, and symbolically. Educational technologies have the power to enhance students’ explorations of patterns by offering opportunities for extending patterns, providing easy-to-use tools for conjecture-testing and allowing students to consider enough number of iterations of patterns in order to generalize mathematical ideas. From supporting students in understanding the equation for a simple linear pattern to allowing students to see the dynamic manipulation of variables in ways that allow them students to see and understand patterns of change in the moment, technology can become a valuable tool for supporting students in engaging in higher-order thinking. In this article, we present two examples of pattern problems (one arithmetic and one geometric) to demonstrate how spreadsheets may support students as they investigate, generate, and understand various patterns and develop specific Standards for Mathematical Practice in the Common Core Standards.

USING PATTERNS TO EXPLORE ARITHMETIC SEQUENCES

Investigating arithmetic patterns can support students in making connections among mathematical concepts as well as connecting classroom mathematics to the world around them. Since arithmetic patterns change by a fixed amount, arithmetic sequences are fairly simple to observe and study. However, they are also robust enough to support students as they make sophisticated conjectures and generalizations. Mathematical software can facilitate the analysis and interpretation of arithmetic patterns. For example, spreadsheets allow students to extend arithmetic patterns by working numerous, rote calculations freeing students to focus on developing generalizations based on the patterns in the spreadsheet. Spreadsheets also allow students to perform manipulations on a pattern and quickly view the effect of the manipulations on the rest of the numbers in the pattern. Clearly, this is beneficial in allowing students to test conjectures. Below is one example of an investigation that exemplifies the value of using technology for solving patterns:

A cruise line has 3-day, 4-day, and 7-day cruises. After each cruise, a ship returns for one day and repeats the pattern. If one cruise of each type leaves today, when will all three cruises leave again on the same day? Generalize your solution for x-day, y-day, and z-day cruises.

The day that each cruise line leaves can be represented as an arithmetic pattern. One possible method of exploring this pattern includes the teacher leading a whole-class discussion in which students are challenged to see the relationships for each cruise line which lasts 3, 4, and 7 days. Another pathway for exploration could be to engage students in a “think-pair-share” strategy in which the students analyze the problem for relevant information and calculate an answer to the first question on their own, then discuss their answer in a pair. In this pair, they could also extend this exploration by generating strategies for solving the problem for x, y and z days. The goal before the technology is used is for the students to develop an initial conjecture that they will be able to test and refine with the technology.

Technology can support learners in thinking mathematically. In the case of the 3-day cruise, the ship will be at sea for three days, return for a day and leave every fourth day. The 4-day cruise will leave port every five days. Further, the 7-day cruise line will leave port every eight days. Using spreadsheet software, students can produce a table (Figure 1). The spreadsheet formula in Figure 1 uses the Integer (INT) function to identify values that yield integers when divided by a given number of days. In this way, the spreadsheet can quickly show students all the days a ship will leave from port for a given schedule and to compare those