Chapter 9
Seeing Numbers Differently:
Mathematics in the Virtual World

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ABSTRACT

Numbers are the most powerful adjective in the human language, being that they are descriptive and quantifiable. Humans can harness that power with our eyes and our innate ability to see shape patterns. Virtual worlds afford us this opportunity without the physical world hindrances of materials, space, time, or gravity. Explore how language, decimal-centricity, and symbols with their processes have clouded the view of numbers, their shapes, and the discovery of metapatterns: visually recognizable algebraic expressions and equations. The experiences shared in the case study within reveal the need of a working virtual world environment for educational training, prototyping, and studio image capturing. Common Core Standards for Mathematics aspire to bring the student into the understanding of the "why". In the virtual reality of Second Life, the metaphor of seeing the forest before the trees is realized with our example and number patterns: from the earliest subitizing, to multi-digit, multi-base number recognition, to metapatterns, to deriving polynomial equations through differences.

INTRODUCTION

How students learn mathematics hasn't changed for over a century. This includes, but is not limited to numbers, number patterns, symbolic codes for quantity, and number processes. Current teaching practices introduce symbols to children when they are learning their alphabet and their counting words. Students spend some time representing quantities visually and with manipulatives. But with class sizes so large and core curriculum topics so varied, there just isn't time to spend in discovery. Common Core is trying

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to address these issues with a deeper development of the 'core' lessons in arithmetic. Multiple perspectives are being investigated, and students are asked to find different avenues to explain the why behind the process (CCSS, 2010). Students still find themselves jumping into symbol manipulation: addition, subtraction, fractions, multiplication, division, etc., and spend a lot of time finding roundabout ways to discuss the essence of number. But these ways still leave a lot of students behind, making catching up a difficult journey as they move through the educational process.

Of those capable of taking on the rigor of higher education, 40% of four-year college students will take at least one Math remediation course and 70% of community college students are placed in remedial math (Okimoto & Heck, 2014; CCRC, 2014), only one-third of students taking those remedial math courses pass. Whereas 27% of those students recommended for help, never end up enrolling (Rikoon, Liebtag, Olivera-Aguilar, Robbins, & Jackson, 2014). Students struggle with the abstractness of mathematics (Hiebert, 1984). In a person's early education, the counting numbers are introduced along with the alphabet, impinging a true understanding of quantity. This counting memorization can still be found in teenagers and some adults when asked to do simple addition and fingers are employed in the process. From these realizations and with the help of a virtual world, three foundational problems have been discovered:

1. Conversational Western languages interfere with recognizing number patterns at an early age. The educational emphasis on counting beyond nine further hinders number sense development.
2. Decimal-centricity (focusing mainly on base ten) impedes the very important discovery of place shapes and metapatterns that exist across multiple base number systems. Focusing the learner exclusively on quantity and place value removes broader and more applicable concepts.
3. The push to use number symbols as the primary source for teaching preschool and elementary school mathematics interferes with and sometimes limits the development of a natural understanding of number processes acquired through physical and visual manipulation of *objects*.

The virtual world is the key. Throughout this chapter, instances will be revealed where and how a virtual world such as Second Life (SL) is used in mathematics instruction. SL opened up a plethora of opportunities for advancement, as it is the largest three-dimensional (3D) virtual world created purely by its users. In short, SL is a "3D world where everyone you meet is a real person and every place you visit is built by people just like you" (www.secondlife.com/whatis). Mathematics is still a relatively new topic to teach using this platform, mostly designated as a space to connect for online immersive discussions and tutoring (Burgess & Caverly, 2009), although some are trying to use this space as traditional teaching with negative results (Cheal, 2009). Innovative use of this virtual space affords a different perspective of mathematics. Scripted devices can show quantities in bases two to ten instantaneously and oscillate between two-dimensional (2D) and 3D at the click of a button, an Equation Board tied to those patterns showing the Algebraic representation of those metapatterns, and the base-conversion calculator link them all. In addition we can show the magnitude of number in relation to an avatar for deeper understanding. SL is used, not only as a prototyping, publishing, and design studio for educational materials in world and out, as seen in the attached figures, but also to immerse a student in the shape of number through activity and engagement. Second Life is a viable option for teaching mathematics.

The purpose of this chapter is to describe an innovative system that has been developed to teach mathematics through the use of Second Life, a virtual world application. First, background knowledge is provided on the importance of recognition of patterns in learning mathematical concepts, and the