

Chapter 16

Strategy Instruction and Maintenance of Basic Multiplication Facts through Digital Game Play

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ABSTRACT

Formative instruction on multiplication primarily focuses on rote memorization. This leads to factual fluency, but also develops a narrow view of multiplication and hinders the development of conceptual understanding. Theory and research recommend the concurrent development of conceptual understanding and factual fluency during the initial stages of learning about multiplication. Woodward (2006) conducted a field study to investigate this instructional approach and found a significant difference between those who received instruction on multiplicative properties and timed-drills of multiplication facts on a conceptual measure than those who only spent time on timed drills. This study investigated the efficacy of integrating the same approach within a digital game. There was a significant decrease between pre- and post-measures of participants timed retrieval of multiplication facts, but no differences were found between conditions on pre- and post-measures of conceptual understanding. These findings indicate that special attention must be paid to intrinsic integration of instructional content in order to address conceptual understanding through digital game play.

INTRODUCTION

It is essential that students develop fluency in basic multiplication during grades three through five, in order to achieve mastery of elementary arithmetic. Instruction during these grades is typically focused on teaching students multiplication facts via drills and rote memorization so they are

able to quickly retrieve answers to multiplication facts. If automaticity of multiplication facts is not developed and maintained, learners typically struggle to develop subsequent math concepts for which multiplication facts are a prerequisite.

In conjunction to the memorization of multiplication facts, students should be presented with the opportunity to learn about and explore the

DOI: 10.4018/978-1-4666-7363-2.ch016

concepts related to multiplication. This allows for the development of mathematical proficiency that goes beyond the computational aspects of multiplication, the limiting and incorrect notion that multiplication is simply repeated addition, and instead have the capabilities to adapt their reasoning, compose strategies to solve multiplicative problems, and have a productive disposition towards multiplication (Lampert, 1986; National Research Council, 2001).

Woodward investigated an instructional approach that combined timed drill and strategy instruction as a possible method of developing automaticity and a conceptual understanding of multiplication of whole numbers (Woodward, 2006). The strategies taught in combination with timed drill were the commutative property of multiplication ($2 \times 3 = 3 \times 2$), derived facts (multiplying by 0, 1, 2, 5, and 10), times itself (3×3), double plus one more ($3 \times 7 = (2 \times 7) + 7$), doubling ($5 \times 4 = \text{double } 5 = 10 = \text{double } 10 = 20$), and adding the digits that make up a product for multiples of nine ($5 \times 9 = 45$; $4 + 5 = 9$). Woodward discovered that students who received strategy instruction along with timed-drill practice of multiplication facts, performed significantly better in posttest measures of conceptual understanding of multiplication than those who just had timed-drill practice of multiplication facts. This study sought to integrate Woodward's instructional approach within the design and development of a digital game for learning.

There already exists an established theoretical foundation that supports the pedagogical benefits of digital game play (Gee, 2007; Shaffer, 2006, Prensky, 2005). In recent years there has been a push towards empirically validating the theories behind games for learning. The results have shown that digital games are engaging, motivating, dynamic environments (Malone, 1984; Malone & Lepper, 1987; Squire, 2005; Habgood, 2005; Adauto & Klein, 2010; Habgood & Ainsworth, 2011). The results have been mixed when investigating learning that can be directly tied to digital game

play. One explanation for the lack of conclusive results tying learning to digital game play is the tendency of instructional games to exogenously represent the instructional content and lean more toward "edutainment" than education (Charoeying, 2010). Furthermore there is very little literature that speaks about the use of digital games for the teaching and learning of mathematics (Swan & Marshall, 2007; Ke, 2008).

The purpose of this formative study is three-fold:

1. Explore the efficacy of digital game to support automatization of multiplication facts,
2. Address the affordances of a digital game as an environment for the exploration of strategy instruction in the support of conceptual understanding, and
3. Evaluate student's attitudes towards the digital game learning environment.

Learning and Teaching of Multiplication

A common misconception about multiplication characterizes it as simply repeated addition (Anghileri, 2001). This definition contributes to a narrow conceptual understanding of multiplication as an operation because it limits multiplication merely to a counting operation. A more accurate understanding of multiplication accounts for both procedures and concepts, which leads to the ability demonstrate adaptive reasoning, strategic competence, and a productive disposition. Lampert (1986) asserts that the repeated addition view of multiplication is not applicable when one has to multiply integers, rational numbers, algebraic quantities, continuous quantities, ratios and proportions. In other words, multiplication is better thought of as an operation that scales quantities, and proficiency is based on a comprehensive understanding of its native procedures, facts, and concepts.

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